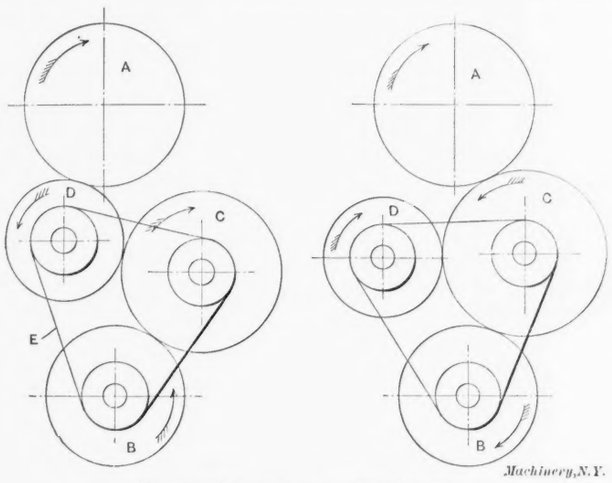
MACHINERY.

December, 1907.

TUMBLER GEAR DESIGN.

JOHN EDGAR.*

OF the different mechanisms that have been used in the machine tools of the past, one—the tumbler gear—could be found in some form or other in almost every machine. Its office, in most cases, was to reverse the direction of the feed. Fig. 1 shows the usual form in which it is found when used for this purpose. The gears *A* and *B* are to be connected so that motion may be transmitted from one, which runs constantly in one direction, to the other, which it is desired to run in either direction. Suppose that *A* is the driver and runs as shown by the arrow. As connected, *A* drives *B* through the intermediate gears *D* and *C*, *B* rotating in an opposite direction to *A*, as shown by the arrows.



Figs. 1 and 2. Examples of Tumbler Gears.

This mechanism is termed the tumbler gear, because the gears *D* and *C* are supported in a frame which swings about the axis of either the driving or the driven gear. In the case in hand, the intermediate gears are carried in the frame *E*, which rotates about the axis of the gear *B*. Some means, not shown, must be provided by which the rocker frame may be changed from one position to the other, and locked. Fig. 2 shows the mechanism shifted so that the motions of *A* and *B* are in the same direction.

The tumbler gear has been used as a reversing gear ever since present forms of machine tools were first invented. While it has always given considerable trouble, it has shown up to disadvantage mostly when applied to the modern machine with positive gear feed, where great power has to be transmitted by it. It is the purpose here to show where this gear may be used to advantage, and also to explain the theory on which the principles of its design are based.

All of us have met with this mechanism in some form or other, and may have formed an unfavorable opinion. The prejudice thus created keeps us from fully appreciating the tumbler gear, even when properly designed, and when used in the right place. It has been placed by many along with the worm drive and the spiral gear as undesirable, and to be avoided unless it is absolutely impossible to get along without it. This opinion has been responsible for the adoption of many combinations used for purposes that rightly belong in the field of the tumbler gear, and many times, in order to avoid using this mechanism, much unnecessary complication has resulted.

What are the faults of the tumbler reversing gear? That one on So-and-So's lathe used to kick furiously when one tried to throw it over. Then, the one used on the milling machine used to go into mesh easily enough, but when any amount of strain was put onto it, the teeth used to crack and growl, showing that the tendency was to drag the gear farther into mesh, causing the teeth to bind on one another and sometimes break. Let us look into the case represented in Fig. 1. Fig. 3 shows the gear *D* just entering into mesh with *A*. An examination of this figure shows that the tendency is for the teeth of gear *A*, when they strike those of gear *D*, to cause the latter to rotate about the axis of the rocker frame, should the gear *B* be locked against turning. This tendency opposes the motion in the opposite direction necessary to bring the gears wholly into mesh. In practice, *B* is not locked, but it is necessary to overcome a certain amount of resistance in order that it may be set in motion, and the presence of this resistance has the same effect as if the gear were locked. The greater this resistance is, the greater is the effort necessary to bring the gears into working position.

Examining the conditions in the case of Fig. 2, we see that the effect would be just the opposite, that is, the gears would come into mesh of their own accord as soon as a contact is produced between the teeth of *A* and *C*. Practically no effort is necessary to bring the gears into mesh, but, in order to withdraw the gear *C* from *A*, considerable effort would be required. When the gears *C* and *A* are in mesh and transmit power, the tendency for gear *C* is to crowd farther into mesh with *A*, which has the effect of binding the teeth. Should the pressure of contact be sufficient, the binding tendency would cause the motion to cease, or would break the teeth.

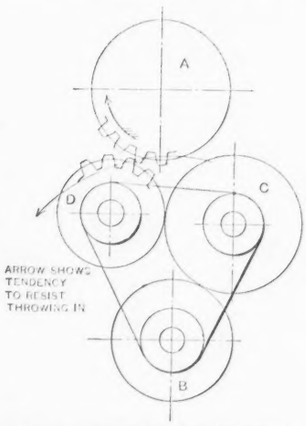


Fig. 3. Illustrating the Tendency to resist Throwing-in of Gear.

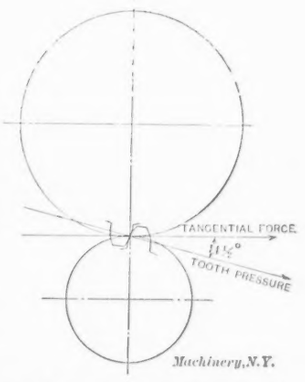


Fig. 4. Illustrating the Direction of Line of Pressure.

This is one of the points on which many have based their verdict against the tumbler gear, and when designed so that such results are obtained, it is not to be wondered at.

Direction of Tooth Pressure in Ordinary Cut Gears.

The first consideration in the design of tumbler gears in any form is that of tooth pressure and its line of application. As all cut gears used in machine tools are made to the 14½-degree involute system, we will confine ourselves to that system. In this, the force tending to revolve the driven gear is not a tangential force, applied as a tangent to the pitch circle, but is a force applied at an angle of 14½ degrees to the tangent of the pitch circle, this 14½-degree line being termed the line of pressure. In case that there may be some confusion as to the above statement regarding the tangential force and the line of pressure on the teeth, the case is graphically shown in Fig. 4. The tangential force is equal to the twisting moment divided by the radius of the pitch circle. This force is equivalent to that which transmits motion between two disks by friction alone, the diameters of the disks being equal to the pitch circles of the gears. This force is,

* Address: 7 Webster St., Hyde Park, Mass.

in the case of a gear, resolved into two component forces. One component acts perpendicular to the tangential force and tends to force the gears apart; the other acts in the direction of the line of tooth pressure shown in Fig. 4. The tooth pressure thus is somewhat less than the total twisting force, and equals the twisting or tangential force multiplied by the cosine of 14½ degrees.

Influence of Direction of Tooth Pressure on Tumbler Gear Design.

To show what effect the line of pressure has upon the layout of the tumbler gear, we will use the simple case shown in Fig. 5. In this figure, *A* is the driving gear and *B* is the driven gear. These gears are connected by means of the intermediate gear *C*, which is carried in the swing frame *E*, which, in turn, swings about the axis of *A*. This mechanism is a simple case of tumbler gear, and while it is little used, it is useful as a means for disconnecting a train of gears when it is desired to stop the motion of the driven section. If we consider the gear *B* locked in the position shown, and exert a turning effort on the gear *A* in the direction indicated by the arrow, this effort is transmitted by the teeth of *A* and *C*, and a pressure is produced between the teeth of *B* and *C*, two of which are shown in the cut. The direction in which this force is applied is shown by the line of pressure *H K*, and is exerted in the direction of *H*. Since every force is opposed by an equal and opposite force when in a state of equilibrium, we have in this instance a force or reaction opposing the force along the line of pressure referred to. It is this reaction that causes our troubles. In the mechanism shown in Fig. 5, the gear *C* and the link *E* are free to rotate about the axis of *A*, and since the line of pressure does not go through the center of gear *A*, the force acting along this line tends to rotate the arm *E* about the axis of *A*, the direction of rotation being dependent on which side of the center of *A* the line falls. Thus in Fig. 5, the line falls in a position that produces a tendency for the arm to force the gear *C* further into mesh with *B*. The twisting moment thus set up is equal to the tooth pressure multiplied by the normal distance from the axis of *A*, or *G L*.

If now, instead of trying to turn the gear *A* in the direction of the arrow, we exert a torque in the other direction, the opposite sides of the teeth would come into contact, and the line of pressure would be located as shown by the dotted

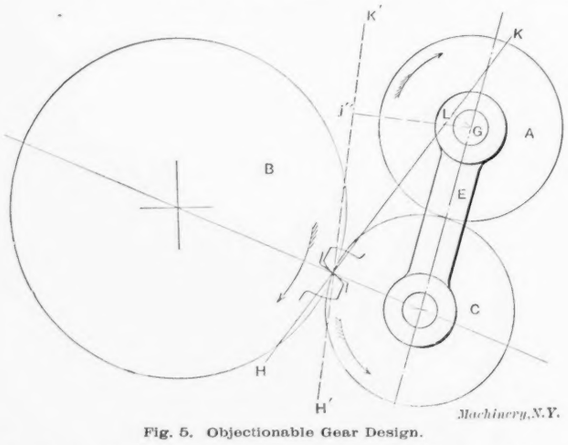


Fig. 5. Objectionable Gear Design.

line *H' K'*. The normal distance of this line from the axis of *A* is much greater than in the former case; consequently the twisting moment tending to rotate the arm *E* about the axis is also increased, but the direction in which the torque is applied has changed the direction in which the reacting force along the line of pressure acts, and, since this line falls on the same side of the axis, the tendency of the arm is to rotate in the opposite direction, and to separate the gears *C* and *B*. Had the line of pressure gone directly through the axis of the gear *A*, where *E* is pivoted, the effect of any force acting along it would have had no rotating influence upon the tumbler gear arm. That this would be the ideal case needs not to be mentioned, and it should be the aim of the designer to approach that condition as nearly as possible.

The tendency for the tumbler to crowd the gears into mesh might be of some advantage were it desirable to throw them into mesh while the gears are in motion; but in cases where any considerable amount of power is being transmitted, a very stiff and rigid design will be necessary for the tumbler frame and the locking device. It is also well in such cases, when setting the locking device, to have the gears mesh with plenty of play or backlash, so that, if there be any give to the frame, the gears will not be likely to bind and cramp. Should *B* be the driver and run in the direction of the arrow, the line of pressure would be *H' K'*, and the pressure would be in the direction of *H'*. The arm would then tend to carry the gear *C* out of mesh with *B*. Should the direction be reversed, *H K* would be the line of pressure, and the tendency would be to crowd the gear in.

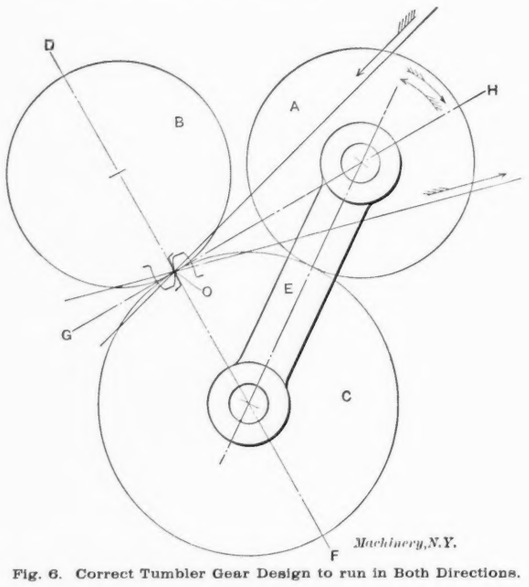


Fig. 6. Correct Tumbler Gear Design to run in Both Directions.

The layout in Fig. 5 has two bad features. In the first place, the gears have a tendency to crowd farther into mesh, which limits the amount of power that can be transmitted, and increases the liability of breakage of the gear teeth and of the tumbler frame should an overload be imposed upon the mechanism. Inaccuracy in the shape and spacing of the teeth aggravates the above conditions. In the second place, the mechanism should be used to transmit motion in but one direction.

In most cases the throwing in or out of the tumbler is a secondary matter as it is done either when the gears are not in motion, or while not under load, if running. In such cases it should be the aim of the designer to overcome the objection of the crowding of the teeth into mesh by having the line of pressure properly located so that the tendency is in the opposite direction. When it is desired to provide a tumbler gear that can be run in either direction, the layout in Fig. 6 is recommended. The object in this case is to have the twisting moment equal in either direction, and such that the gears have no crowding tendency. The arrangement in Fig. 6 is laid out as follows: Draw the pitch circles of the gears *B* and *C* and connect their centers by the line *D F*. Through the pitch point *O* draw a line *G H* normal to *D F*. Then locate the gear *A* at some point on *G H* so that its pitch circle will be tangent with that of *C*.

The Single Tumbler Gear.

The single tumbler gear is the basis of many of our modern rapid change speed and feed mechanisms, and the principles treated above apply to this as well as to the simple tumbler gear. Take the simple case shown in Fig. 7, which shows the pitch circles of a four-gear cone and the driver *A* and tumbler gear *C*. It is evident that only one position of the gear *C* can be such that the ideal condition prevails, that is, only when in mesh with one gear of the cone can the line of pressure pass through the axis of the tumbler frame. Fig. 7 shows this to be the case when *C* is in mesh with the gear *B'*. Each subsequent shifting of the tumbler along the cone brings the line of pressure eccentric to the axis until the position

of extreme eccentricity is reached when C is in mesh with B''''. In mechanisms of this kind, it should always be the aim of the designer to have the line of pressure pass as close to the center of rotation of the tumbler frame as is possible, because the locking devices used with this type of tumbler gear are necessarily of such a design as to be quick in action, and in consequence are not very stiff or rigid. The line of pressure should always be made to fall on that side of the axis where the tendency is to separate the gears rather than to bring them closer together. When the gear C is supported in a swinging frame which does not slide in a lateral direction, but the changes are made by shifting C along an intermediate shaft, the supporting member should be located at the end where the line of pressure has the greatest eccentricity, as the greatest strain comes at that end. Thus, in Fig. 7 the support should be at the same end as B''''. The diameter of the intermediate gear C has an important effect on the location of the line of pressure. It will be found that it should in most cases be as large as B'''', in order that the line of pressure may come right. However, no exact rule can be given by which the diameter of C can be calculated, as it depends greatly on the difference in the diameters of B' and B'''', and also on the diameter of A.

Rules for the Design of Tumbler Gears.

What direct rule can be given that may be used as a guide in laying out the tumbler gear? Referring to Fig. 5, we see that the gear C is revolving in a direction away from the axis of the tumbler at the point of tangency of the pitch circles of C and B, and that the reacting force tends to crowd the gears farther into mesh. Had this line of pressure fallen on the other side of the axis of the tumbler frame, the tendency would have been opposite in effect. When the gear C is revolving so that a point on the pitch circle travels away from the pivot of the tumbler, and the line of pressure falls

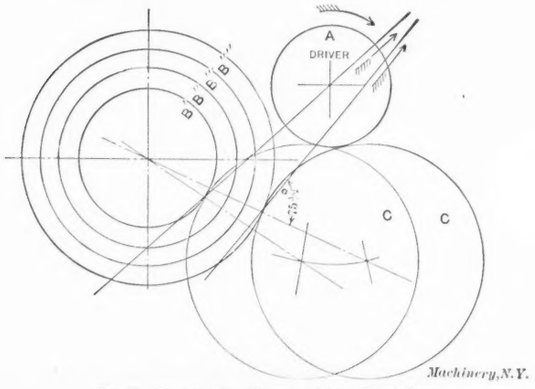


Fig. 7. Single Tumbler Gear in a Feed Box.

somewhere between the pivot point and the axis of the driven gear B, the tendency will be to crowd. From this we therefore may formulate the following rules:

Rule I. When the gear about which the tumbler gear swings is the driver, and the line of pressure falls between the axis of that gear and that of the driven gear, the motion of a point on the pitch circle of the tumbler or intermediate gear, when near the contact point, must be toward the axis of the tumbler frame. Should the direction of a point on the pitch circle be opposite, the line of pressure must fall outside of that area included between the axis of the pivot gear and the driven gear.

Referring again to Fig. 5, it is seen that should the driving gear be B, the above rule does not apply, but may be altered to read thus:

Rule II. When the gear about which the tumbler gear swings is the driven gear, and the line of pressure falls in the space between the axis of this gear and that of the driving gear, the motion of a point on the pitch circle of the intermediate gear at the contact point must be away from the axis of the pivot gear; when the line of pressure falls outside of this space this motion must be reversed.

By following these two rules, more as a precaution than as a compulsory condition, much better success may be expected in the results obtained.

NEW BUILDING FOR THE AMERICAN SCHOOL OF CORRESPONDENCE.

The building recently erected for the American School of Correspondence, Chicago, is of particular interest from both the architectural and the educational point of view. This new home of home study is marked by solidity, dignity and usefulness. In its external, visible lines, it harmonizes with the

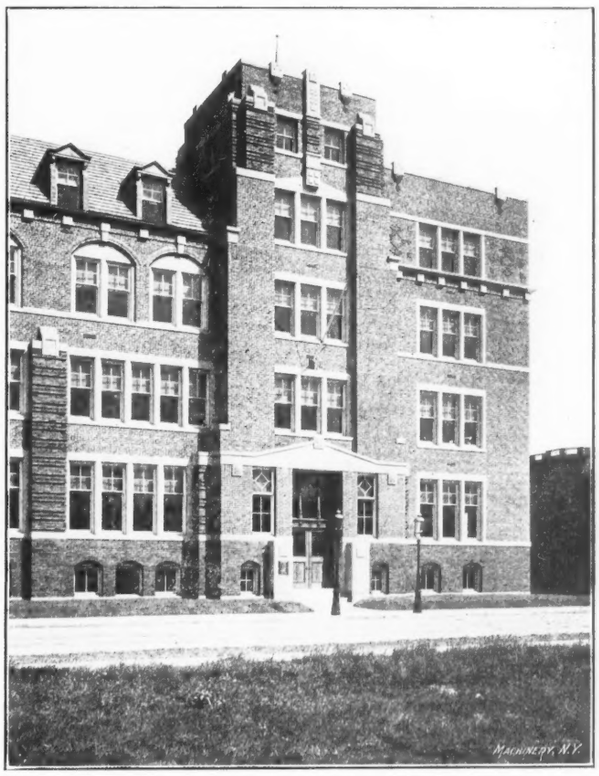


Fig. 1. Detail of Tower, New Building American School of Correspondence.

practical purposes of its design. The structure partakes to some extent of the nature of an office building as well as a school. Its design was, therefore, a complex problem dictated by several different considerations. First, of course, was its intended use as a school and a center of administration; but a factor of almost equal weight was its location. It stands in the immediate vicinity of the magnificent Washington

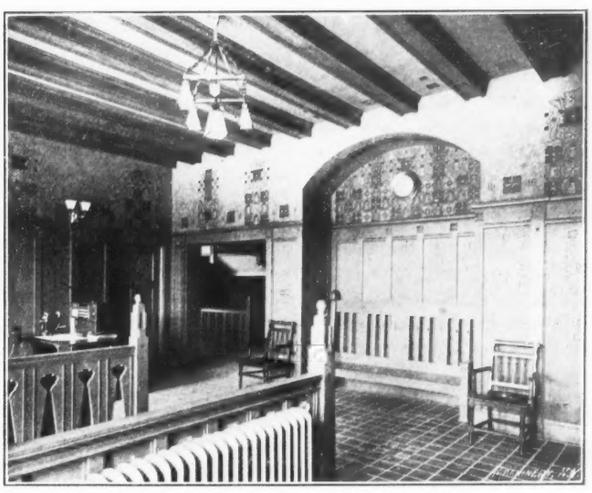


Fig. 2. Entrance Hall, New Building American School of Correspondence.

Park and the Midway Plaisance of World's Fair fame, now an essential link in Chicago's great boulevard system. Thus it has the advantages of surroundings of great natural beauty and artificial adornment. The administration offices of the University of Chicago stand only two blocks away.

The building faces south. It contains four stories and basement. The general interior plan is that of the letter E;

the return of the east and west wings encloses on two sides an open court, 60 feet square, walled in at the rear end and entered through an arched driveway.

The materials of the exterior are paving brick of two shades, with Bedford stone for enrichment, and moss-green tile in the roof. The brick used in the basement and projecting corners of the rustications is of a purplish red, somewhat darker than that used in the body; its depth of tone is strengthened by its being laid with dark joints. The brick in the body of the wall is a medium warm red, variegated enough to have life and pleasing texture; its general contrast to the darker material is emphasized by its being laid with white joints, and by the white finish of the window sash and frames.

The note of green struck in the roof tiling is carried throughout the interior wood finish of the building, which is of quartered oak; the notes of purple and red reappear in the wall decoration, and the red in the polished granite of the entrance steps. Red is also present in the flooring of the vestibule and corridor on the ground floor, which consists of plain red English quarry tile, laid with broad, dark joints, and relieved by occasional mosaics of glazed and varicolored tiling. The general interior color scheme is seen to best advantage in the vestibule. The high oaken wainscoting, the ceiling beams, and the furnishings are tinted a soft green; the walls and ceiling panels a warm buff, relieved with unique, conventional flowered designs in red, green and purple—the whole blending harmoniously and in pleasing contrast with the general darker tinting of the tiled floor.

The administrative offices of the school are on the second floor; the remainder of the building is used for the accommodation of the large staff of instructors, editors, and other employes in charge of the various details of the work of the school. An interior telephone system connects all departments. To facilitate the work of the business office and mailing room, several of the latest electrical appliances have been installed, including adding machines, folding machines, and envelope sealers—all operated by electric power. In the basement are the stock room, the shipping room and the steam-heating plant. The system of heating is known as the "direct-indirect"; the larger radiators are located in juxtaposition to cold-air ducts that lead from the outside through the walls, and that supply an abundance of fresh air at all times. Electricity is used throughout for lighting purposes. The corridors and larger rooms are equipped with Nernst lamps, the other parts of the building with incandescent lamps. Lavatories with hot and cold water are located on each floor.

On the second floor are the lecture room, and the rest room for employes. The lecture room is used as a meeting place for the clubs that have been formed at the works of the Crane Co., the McCormick Harvester Co., and other large manufacturing plants in and near Chicago. At these plants students of the American School of Correspondence have organized, appointed leaders from their own number, and found mutual assistance in studying together. From time to time they meet in the lecture room of the school, where they are provided with instructors, apparatus, and—since most of them come direct from the shop to the school—with a substantial lunch, all for the usual tuition. The school also provides its employes with free coffee and lunch at noontime.

It is the purpose of the American School of Correspondence to take into every home the educational facilities offered by the best resident technical schools; to make it possible for every man, irrespective of age, occupation or condition, to educate himself at home during his spare time; to give the wage earner, the mechanic, the man who has "never had a chance," an opportunity to fit himself for the position in life which he desires to fill.

* * *

It has been estimated that every person in the United States uses, annually, about seven dollars' worth of electricity in some form. Trolley rides lead at $3 per capita; electric light is second with $1.50 per capita. Every man, woman and child buys $1.25 worth of electric apparatus and supplies, uses 75 cents' worth of telephone service, and 50 cents' worth of telegrams and alarms.

BRITISH FILE-TESTING MACHINE.

In the October issue an article on file testing by Mr. Oscar E. Perrigo was published, which gave simple directions for testing files without an apparatus. Presumably this article called forth from Edward G. Herbert, Ltd., Manchester, England, the following description and illustration of that concern's file-testing machine, which was invented in 1905. This machine was designed to give a perfectly reliable mechanical test of hand files and an autographic record of the results produced by each file tested. The machine has revealed an extraordinary difference of quality in files, some files being worn out after filing away less than 1 cubic inch of iron and cutting at the rate of only 1 cubic inch per 10,000 strokes, while the best files (size not given) remove 12½ cubic inches of metal and cut at the rate of 5 cubic inches per 10,000 strokes.

The publication of these results a year or so ago created a sensation in the English file trade, and a public file-testing department was established, and the testing machines were supplied to a number of file makers. The surprising and perhaps, in some cases, painful results obtained by these testing machines at once stimulated file makers to improve their product, and the result has been a general improvement of English files.

The extent of the improvement will be noted from the diagram Fig. 1, being the record of the files tested since the introduction of the file-testing machine. Curve 2 indicates that over 45 cubic inches of iron were removed and 160,000 strokes were made before the file ceased to cut. Still better results have been obtained since this sheet was published, files now being made which cut at the rate of 8 cubic inches per 10,000 strokes, and as much as 55 cubic inches have been removed by one side of a single file. Thus, the file-testing machine is directly responsible for an increase of efficiency of very nearly ninefold in the best files, and the end is not yet.

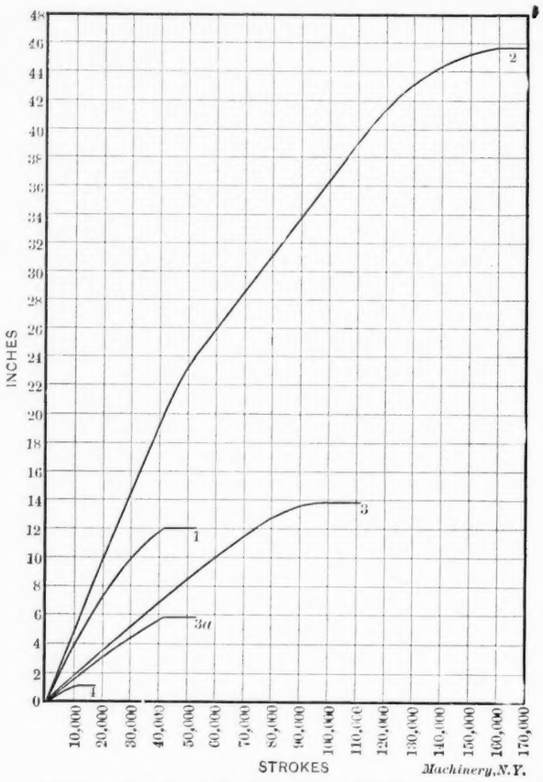


Fig. 1. Records made by File-testing Machine, showing Comparative Life and Cutting Power of Good and Bad Files.

Fig. 2 shows the general construction of the machine. It automatically tests files of any size from 4 to 16 inches and draws a diagram, at the same time indicating the work done in cubic inches. The sharpness of the file is shown by the rate of cutting, and the durability, by the number of strokes taken before the file ceases to cut.

The file *A* to be tested is held between two head-stocks *B* B_1, on a reciprocating table *C*. Head-stock *B* is provided with a nut and a hollow squared screw *D* for holding the tang of the

file and exerting end pressure. Head-stock B_1 has a slide and a hand-wheel E, whereby the file may be adjusted with its working face parallel to its direction of motion.

The reciprocating motion of the table is obtained from the pulley and main shaft through a pair of bevel wheels, driving a T-slotted crank disk. A crank-pin, whose position in the T-slot can be varied according to the stroke required, carries a slide block of rectangular form, which slides between two vertical bearing surfaces in an extension of the table C, and serves to drive the latter to-and-fro. The driving mechanism is inside the box frame of the machine and entirely protected from the filings. The machine is started and stopped by a clutch operated by a handle F.

The test bar G is supported in a horizontal position on grooved rollers, and is pressed against the file by a weight H and a chain passing over a pulley and under the bar, to the

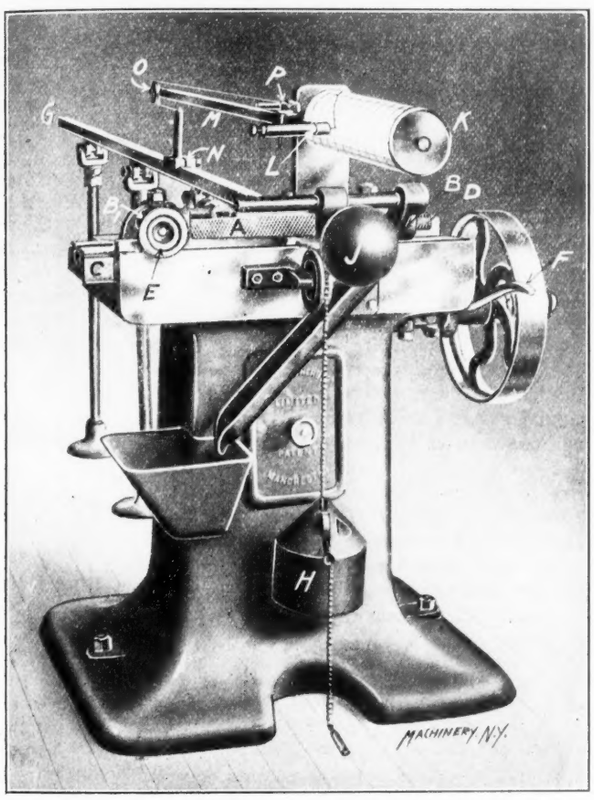


Fig. 2. File-testing Machine built by Edward G. Herbert, Ltd.

far end of which the chain is attached. The support rollers are grooved to accommodate the chain. The bar is drawn out of contact with the file during the back stroke of the latter, by means of a clutch lever having two hardened jaws embracing the test bar. At the commencement of the back stroke, motion is communicated from a cam on the crank shaft to the outward end of the clutch lever, causing it to tilt and grip the test bar after the manner of a spanner. A slight continuation of the same motion causes it to draw back the test bar, which is again released at the commencement of the forward or cutting stroke. A spherical weight J with a screwed stem, is supported by the head-stock B, and, of course, reciprocates with the file. The end of the stem rests against the back of the file, and the inertia of the weight prevents the chattering and jarring of the file which would otherwise take place. The drum K, round which is wrapped the diagram sheet of squared paper, is driven from a cam on the crank shaft through a pawl and ratchet wheel and a train of reducing gears, so as to make one revolution to 120,000 strokes of the file. A pencil L is pressed against the paper by a light spring, and is carried on a bar M, capable of sliding longitudinally in a fixed bearing. A block N is attached to the test bar, and a fusee chain is attached to this block, and, passing over a pulley O on the pencil bar, is held by a fixed terminal P. It is evident that as the test bar is filed away it is moved forward by the weight H, and a given movement of the test bar causes the pencil to move forward by half that amount. The diagram sheet is graduated in half inches, each of which represents one inch filed off the test bar. The circumference of the drum is 12 inches, and as it revolves under the pencil each inch represents 10,000 strokes of the file. At the commencement of a test, the pencil is set to zero, and, as the drum revolves and the test bar is filed away, a curve is drawn by the compound motion of the drum and pencil. This curve is a complete picture of the life of the file from the commencement of the test until the file is worn out and ceases to cut, the slope of the curve indicating the sharpness or rate of cutting, while the vertical and horizontal ordinates give, respectively, the total amount of work done by the file, and the number of strokes required to do this work and to wear the file out. For example, in Fig. 1, curve 2 shows that the maximum rate of cutting was during the first 15 inches. The efficiency slowly decreased up to 42 cubic inches, when it dropped off rapidly. Cessation of cutting took place at the beginning of the short horizontal line.

On the same diagram, curve 1 was made from a file of good average quality, as usually supplied by the same makers. It cut quickly, but soon wore out, showing that it had sharp teeth, but it was made of poor steel. Curve 3 and 3*a* were made from the two sides of another file. The durability was fair, but the rate of cutting was slow. These diagrams indicate that the file was made of good steel, but had poorly shaped teeth. These diagrams are also interesting in showing the great difference that may exist between two sides of a carelessly made file. Curve 4 was made with a very bad file. It was practically worn out after having removed 1 cubic inch of metal, and 10,000 strokes were required to remove even this small amount.

* * *

DESIGN OF LIGHT STRUCTURAL JIB CRANES.*

W. H. BUTZ.†

In this article, the method of computing the stresses in the various members of the crane in Fig. 1 will be taken up in their proper order. This type of crane is commonly styled

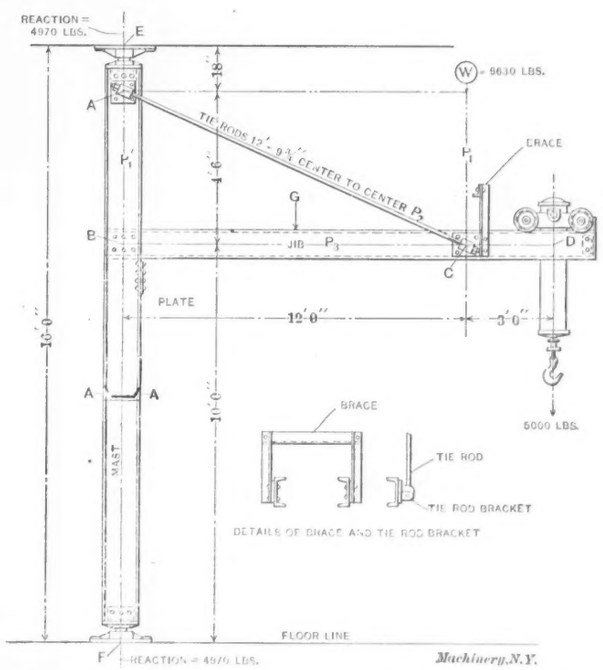


Fig. 1. Outline of the Crane of which Members are to be Calculated.

a jib crane; the radial arm being the jib, and the vertical arm the mast. The tie rods are the adjustable type, the nuts on the end allowing for accurate leveling of the jib when installing crane. A straight lift pneumatic hoist is shown, being the type most familiar to the writer. Assuming the capacity of the hoist as 4,500 pounds, and weight of hoist

* For additional information on cranes and kindred subjects see MACHINERY, November, 1907: Power Required for Cranes and Hoists, and other articles referred to in connection with the article in that issue.

† Address: 27 Clinton Ave., Plainfield, N. J.

and carriage as 500 pounds, the total load on the crane will be 5,000 pounds.

Stresses in Jib and Tie Rods.

To arrive at the stresses or loads in the jib and tie rods, the parallelogram of forces is required, see Fig. 2. Draw P_1 to some scale representing the weight of the load, P_2 parallel to the center line of the tie rods, P_3 parallel to the jib, and complete the parallelogram as determined by length of P_1. Now the forces in P_2 and P_3 will be proportional to P_1, when measured to the same scale.

Let W = load,
S_t = tensile stress in the tie rods,
S_c = compressive stress in the jib.

Then we have:

$$S_t = \frac{W P_2}{P_1} \qquad (1)$$

$$S_c = \frac{W P_3}{P_1} \qquad (2)$$

From this it will be seen that the stresses in jib and tie rods are proportional to their length (figured, of course, on the center lines) and the writer would like to say, before going any further, that he has found it the quicker way to use the actual lengths of same in the formulas, making P_1 in Fig. 2 = to distance $A\,B$ on the mast in Fig. 1. All three dimensions (P_1, P_2 and P_3) have to be figured in working up the crane, and after that the slide rule simplifies matters.

Bending Moments and Stresses in Jib.

The first step is to get at the size and weight of beam to use in the jib, as this will add some to the pull exerted in the tie rods by the actual load. It will be seen that $C\,D$ in Fig. 1 equals one-fourth of $B\,C$. This is the most economical location for the tie rod supports, as a glance at the formulas

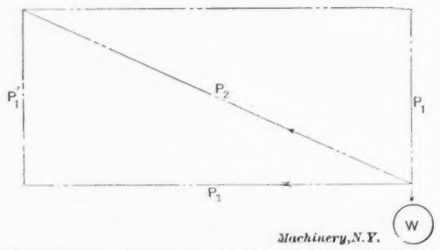


Fig. 2. Force Diagram for the Mast, Jib and Tie Rods.

for bending moments will show. When the load is central between B and C, or at G, we have a beam supported at the ends, and a load in the middle. With the load at D, it is a cantilever, fixed at C, and the load at the end.

Let P = superimposed load (concentrated at one point),
W = total weight of beam,
l = length of beam in inches,
M = bending moment in inch-pounds.

Then for the beam supported at the ends,

$$M = \frac{Pl}{4} + \frac{Wl}{8} \qquad (3)$$

and for the cantilever

$$M = Pl + \frac{Wl}{2} \qquad (4)$$

From this it will be seen that M in a cantilever is four times as great as in a beam of the same length, and the bending moment in either case being proportional to the length of beam, to make the moments equal will require a cantilever one quarter the length of the beam.

When we figure the beam with the load at G, it is also of the proper strength for the load at D. Substituting in formula 3, and assuming that we will use a 10-inch channel, weighing 15 pounds to the foot (remembering that there are two of them), we have:

$$M = \frac{5{,}000 \times 144}{4} + \frac{360 \times 144}{8} = 186{,}480 \text{ inch-pounds.}$$

To get the stress per square inch in the extreme fibers of the beams, we have the formula

$$S = \frac{Mc}{I}. \qquad (5)$$

S = stress in extreme fiber.
M = bending moment in inch-pounds.
c = distance from neutral axis to extreme fiber, in inches.
I = moment of inertia of section, in inches (both beams).

$$S = \frac{186{,}480 \times 5}{66.9 \times 2} = 6{,}958 \text{ pounds per square inch, com-}$$

pression in the upper flange, and tension in the lower.

(Note.—The sizes and properties of standard structural shapes can be obtained from any of the steel companies' handbooks.)

In addition to this stress, there is a compressive stress due to the thrust back in the jib. With the load at G, one-half of it, or 2,500 pounds, is supported by the tie rods, together with one-half the weight of the beams between B and C, or 180 pounds, and about 200 pounds additional for the parts outside of C, making a total of 2,880 pounds. Substituting in formula (2), we have:

$$S_c = \frac{2880 \times 144}{54} = 7680 \text{ pounds.}$$

Dividing this by the sectional area of both beams, we have:

$$\frac{7{,}680}{4.46 \times 2} = 861 \text{ pounds per square inch.}$$

Adding this to our stress due to bending moment, we have $6{,}958 + 861 = 7{,}819$ pounds per square inch compressive stress in the upper flange; and deducting $6{,}958 - 861 = 6{,}097$ pounds per square inch tensile stress in the lower flange.

Taking up the allowable stresses in the beam, as compared with stresses obtained above, we find from the handbooks that 12,500 pounds per square inch is the proper working stress (for moving loads) in structural shapes used as beams.

But, we now have to consider an extremely important point. The upper flange is in compression, which makes the same conditions hold as in a column. The longer the column, the lower the allowable working stress, on account of the tendency to buckle in the center, and unless the top flange of our beam can be supported from buckling sideways, the proper reduction must be made to meet this.

Let p = allowable stress in pounds per square inch,
l = length between lateral supports, in inches,
b = width of flange, in inches,

$$p = \frac{18{,}000}{1 + \frac{l^2}{3{,}000b^2}} = \frac{18{,}000}{1 + \frac{144^2}{3{,}000 \times 2.6^2}} \qquad (6)$$

$$= 8{,}880 \text{ pounds per square inch.}$$

The allowable stress is 8,880 pounds, and the actual stress is 7,819 pounds, which gives a good margin and insures a stiff crane.

If a 9-inch 13¼-pound channel is looked into, the stress, as calculated from formula 5 (even disregarding the back thrust), will be 8,850 pounds per square inch, while the allowable stress, calculated from formula 6, is only 8,200 pounds, showing that the 10-inch channel is the proper one to use.

The vertical load at C, Fig. 1, with the hoist at D, will be proportional to the lever arms $B\,D$ and $B\,C$.

$$\frac{5{,}000 \times B\,D}{B\,C} = \frac{5{,}000 \times 15}{12} = 6{,}250 \text{ pounds.}$$

Add to this half the weight of beams between B and C, equals 180 pounds, and 200 pounds for structure outside of C, and the total vertical load at C = 6,630 pounds.

Still another condition to consider is with the load at D. This makes the jib virtually a beam with an upward load at B and downward at C and D, with the added complication of a compressive stress applied at C due to the thrust from the tie rod. Perhaps the best way to calculate the stresses in the part in question, however, will be to consider $C\,B$ as a cantilever fixed at C with the load at D. We may then find the maximum compressive stress due to the flexure at C, and add to it the compressive stresses due to the thrust of the tie rods. Adding together the bending moment due to the 5,000 pounds load, and that due to the weight of the channels and other parts to the right of C, we have

$$M = (5{,}000 \times 36) + (200 \times 18) = 183{,}600 \text{ inch-pounds.}$$

To find the stress per square inch in the extreme fibers of the beams, use formula (5),

$$S = \frac{183{,}600 \times 5}{66.9 \times 2} = 6{,}860 \text{ pounds per square inch.}$$

To this, as before mentioned, we have to add the unit compressive stresses to the thrust on the jib. The total compression is found from formula 2.

$$S_c = \frac{6{,}630 \times 12}{4.5} = 17{,}680 \text{ pounds.}$$

Dividing this thrust by the combined area of the two channels to find the unit compressive stress, we have

$$\frac{17{,}680}{2 \times 4.46} = 1{,}980 \text{ pounds.}$$

The maximum compressive stress immediately to the left of point C is then

$$6{,}860 + 1{,}980 = 8{,}840 \text{ pounds per square inch.}$$

As in the previous case, with the load half-way between B and C, we should examine this condition for safety of the beams as regards failure by buckling. Considering the unstayed length as being that between B and C, as before, we have the same maximum permissible stress of 8,880 pounds per square inch, as given, then, by formula No. 6. It will be seen that our result falls just short of this maximum amount, so we may consider the channels as properly selected.

[In this second case, with the load at D, we would not feel safe in considering the length of the beam as that between B and C when applying formula (6), unless the construction of the brace at C is made differently from that shown, in which case it is possible for the girder to buckle by spreading sidewise at the point where the brace is attached. We would suggest that a cross lattice, or a wide plate, with three or four rivets in each side, be used to connect the two angle uprights shown, rather than to use the single cross angle section with the single riveting, as called for by the sketch.—EDITOR.]

Size of Tie Rods.

The tie rods must be proportioned to stand the load at D, which is the worst condition. As already figured, the vertical load at $C = 6{,}630$ pounds (with hoist at D).

Substituting in formula (1):

$$S_t = \frac{6{,}630 \times 153.75}{54} = 18{,}875 \text{ pounds.}$$

$$\frac{18{,}875}{2} = 9{,}438 \text{ pounds pull on one rod.}$$

Allowing 10,000 per square inch as a safe working stress,

$$\frac{9{,}438}{10{,}000} = 0.944 \text{ square inches area required at the root of}$$

the thread, giving a 1¾-inch rod, having an area of 1.053 square inch. A 1¼-inch rod would not be strong enough, having an area at the root of thread of only 0.889 square inch.

Tie Rod Brackets.

These are merely a matter of good design, only making sure that there is sufficient metal to take care of the shearing stress. The rivets for holding the brackets in place must be figured for shear, and for bearing pressure in the channel. We need not discuss the shear, and the safe bearing pressure on rivets in structural work is taken as 20,000 pounds per square inch of projected area in the rivet holes.

One more word with regard to placing the tie-rod brackets at C. The pull of the rods at one side will have a tendency to twist the beams, unless an overhead brace is used as shown. If conditions will not allow this brace, then the rods should be carried very close to the end of the jib.

Stresses in Mast.

This can be arrived at in two ways. Consider the mast as a beam fixed at A, supported at F, and the load at B equal to the greatest back thrust of the jib. A rather complex formula is required for this, and the much simpler method is to figure the reactions on the top and bottom supports, and consider the bottom reaction as a load at the end of a cantilever, fixed at B, and equal to $B\,F$ in length. The ratio of the reaction on supports to the load at C is proportional to lever arms $B\,C$ and $E\,F$.

$$\frac{6{,}630 \times B\,C}{E\,F} = \frac{6{,}630 \times 12}{16} = 4{,}970 \text{ pounds reaction.}$$

M = bending moment in inch-pounds.
P = load = reaction on bearing.
l = length of cantilever in inches = $B\,F$.
$M = Pl = 4{,}970 \times 120 = 596{,}400$ inch-pounds.

Substituting in formula 5, and using two 15-inch 33-pound channels, we have:

$$S = \frac{596{,}400 \times 7.5}{312.6 \times 2} = 7{,}155 \text{ pounds per square inch.}$$

The stress for vertical load will add a few hundred pounds to this, but need not be considered in this case, as we have a considerable margin, and the plate shown underneath the jib will prevent side buckling of the compression flange, so that we can figure on the full working stress of 12,500 pounds per square inch. If the stress were very near the limit, then this point would have to be taken up more thoroughly.

A 12-inch channel, 20½ pounds, gives a fiber stress of 14,000, which is too high. A 12-inch channel, 35 pounds, gives only 10,000 per square inch, which would be strong enough, but would not be as economical or as stiff as the 15-inch 33-pound beam, weighing, as it does, 2 pounds more to the foot.

With the hoist at the extreme back of jib, the mast should be considered as a column from B to F. Using formula,

$$P = \frac{50{,}000}{1 + \frac{(12L)^2}{24{,}000r^2}},$$

in which

P = ultimate strength, in pounds per square inch.
L = length of column, in feet.
r = least radius of gyration in inches, or about axis $A\,A$, in Fig. 1.

We have

$$P = \frac{50{,}000}{1 + \frac{(12 \times 10)^2}{24{,}000 \times 0.91^2}} = \frac{50{,}000 \times 19{,}850}{34{,}250} = 29{,}000 \text{ pounds}$$

per square inch, ultimate strength.

Using a safety factor of five for moving loads.

$$\frac{29{,}000}{5} = 5{,}800 \text{ pounds per square inch, safe stress.}$$

Figuring approximately, the load with the hoist at the back is 5,000 pounds, half the weight of jib channels between B and C equals 180 pounds, and the weight of mast parts above B equals 500 pounds, giving a total of 5,680 pounds.

It will be seen from the above that the allowable stress per square inch is greater than the total load on both channels, so that this stress can be ignored entirely in this case, and as a rule, when the mast has been figured for the bending moment, with the load at D, it will be perfectly safe with the load at the back of jib.

Top and Bottom Bearings.

These should be designed with pins amply large to give low bearing pressures, and to take care of shear and bending moments due to the reaction. The bottom plate ought to be large enough to spread the weight over a fairly large area of the foundation. These last points, however, need not be considered here, as this article is intended chiefly to cover the design of the structural portions of the crane.

* * *

Wood Craft calls attention to an important point that is sometimes overlooked by designers who make use of soft rubber as a material for springs. Everyone is familiar with the elasticity of soft rubber. An unconstrained piece of this material, however, acts altogether differently from what it does when it is prevented from changing its shape. Enclosed in a rigid cylinder with an easy fitting cover, it resists pressure solidly and fully, but when free of the cover and allowed to change its form, then it increases in girth exactly as it shortens in length. More than one failure of a rubber spring to do its destined duty has been due to sheer oversight on the part of the machine designer in not giving room for this expansion.

DERIVATION OF THE CROSS-ROLL CURVE.*

ULRICH PETERS.†

The writer offers in the following a practical solution of the mathematical problem known as "the cross-roll curve." This curve is similar to the hyperbola, the curve generating the hyperboloid, but is not the same curve. The cross-roll machine is extensively used for removing the scale on the surface of pipes and round shafts, thereby smoothing, rounding, and to a great extent straightening the work. The angle of the cross-rolls gives rotative and longitudinal motion at the same time to a tube while it is going between the rolls of the machine. The construction of these machines is usually such that on smaller machines there is one cross-roll above and one below, while on larger machines, the cross-rolls are arranged one on each side of the pass. For shaft-

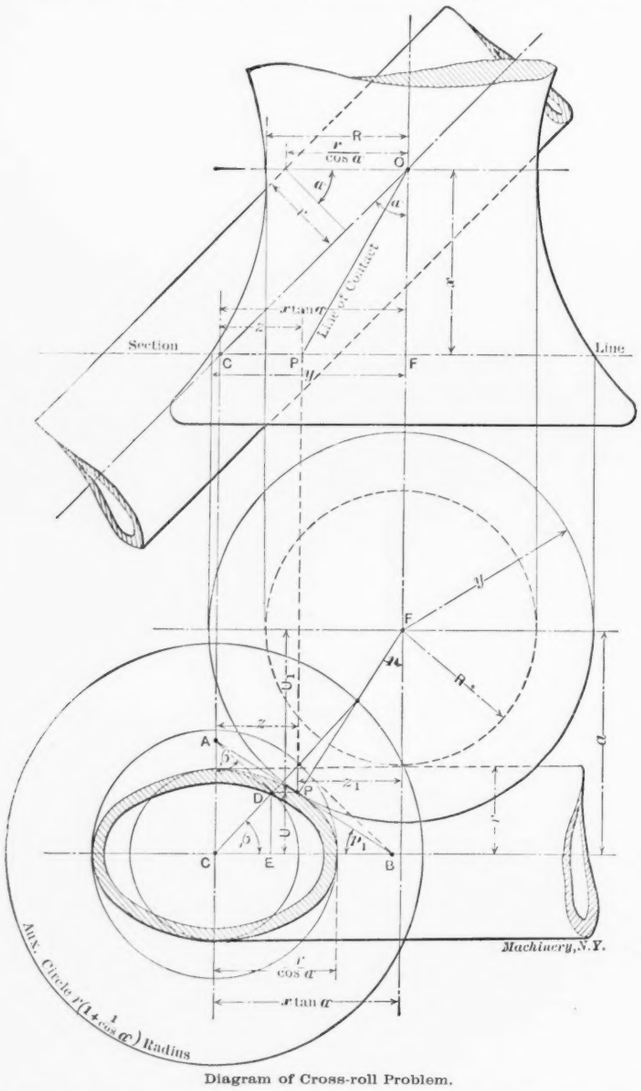


Diagram of Cross-roll Problem.

ing, the best straightening effect is obtained with only one cross-roll working opposite a cylindrical roll, the latter being parallel to the press. The turning of these cross-rolls in the lathe requires considerable skill. The simplest way is to form them to a templet. Of course the work is very much simpler if in connection with this templet an automatic forming lathe attachment is used. The formulas I and II given in the following may be used for determining the true profile of the templet or former.

Let the projected angle of rolls axis on the pipe axis $= \alpha$; the parallel distance of roll axis to billet or pipe axis $= a$ (constant); the middle radius of the cross-roll $= R$; and the outer radius or billet or pipe $= r$.

A section at right angles to the axis of the cross-roll at any distance x from the middle O of the roll (the starting point) will intersect the pipe at an angle. This section when projected, as shown in the lower figure, will show the section of the cross-roll as a true circle of the unknown radius y, and the billet or pipe as an ellipse with half of minor axis $=$ r, and the major axis $= \dfrac{r}{\cos\alpha}$. Both curves touch at a point P where the tangent $A\,B$ is common to the circle of the cross-roll and at the same time to the ellipse of the pipe, so that $\tan p = \tan p_1$.

By introducing further z, U and z_1, U_1, for abscissæ and ordinates in the ellipse and the circle, respectively, we have according to analysis for the ellipse and circle:

$$z^2\cos^2\alpha + U^2 = r^2 \quad (1) \qquad z_1^2 + U_1^2 = y^2 \quad (2)$$

In the cut it is apparent that $R + r = a$ (3)

$$U + U_1 = a \quad (4) \qquad z + z_1 = x\tan\alpha \quad (5)$$

We also have $\tan p = \tan p_1$, or $\dfrac{z_1}{U_1} = \dfrac{C\,A}{C\,B}$, wherein

$C\,A = \dfrac{r}{\sin\beta}$, and $C\,B = \dfrac{r}{\cos\alpha\cos\beta}$. Therefore

$$\frac{C\,A}{C\,B} = \tan p_1 = \frac{r}{\sin\beta}\times\frac{\cos\alpha\cos\beta}{r} = \operatorname{cotan}\beta\cos\alpha.$$

Herein $\operatorname{cotan}\beta = \dfrac{C\,E}{D\,E} = \dfrac{\sqrt{r^2-U^2}}{U}$

and writing for $\sqrt{r^2-U^2} = z\cos\alpha$ (taken from formula 1), it follows that for $\tan p = \tan p_1$, can be substituted the following:

$$\frac{z_1}{U_1} = \frac{z}{U}\cos^2\alpha \quad (6)$$

By substituting for $z_1 = \dfrac{U_1 z}{U}\cos^2\alpha$ (from 6) in (2) and (5):

$$y^2 = \left(\frac{U_1 z}{U}\cos^2\alpha\right)^2 + U_1^2 = U_1^2\left(1+\frac{z^2}{U^2}\cos^4\alpha\right) \quad (2a)$$

$$x\tan\alpha = z + \frac{U_1 z}{U}\cos^2\alpha = z\left(1+\frac{U_1}{U}\cos^2\alpha\right) \quad (5a)$$

By substituting for $U^2 = r^2 - z^2\cos^2\alpha$, or $U = \sqrt{r^2 - z^2\cos^2\alpha}$ (from equation 1) into (4), (2a) and (5a):

$$a = \sqrt{r^2 - z^2\cos^2\alpha} + U_1 \quad (4a)$$

$$y^2 = U_1^2\left(1+\frac{z^2\cos^4\alpha}{r^2 - z^2\cos^2\alpha}\right) \quad (2b)$$

$$x\tan\alpha = z\left(1+\frac{U_1\cos^2\alpha}{\sqrt{r^2 - z^2\cos^2\alpha}}\right) \quad (5b)$$

Finally, substituting from (4a) for $U_1 = a - \sqrt{r^2 - z^2\cos^2\alpha}$ into formulas (2b) and (5b), we obtain:

$$y = \left(a - \sqrt{r^2 - z^2\cos^2\alpha}\right)\sqrt{1+\frac{z^2\cos^4\alpha}{r^2 - z^2\cos^2\alpha}} \quad \text{and} \quad (\text{I})$$

$$x = z\operatorname{cotan}\alpha\left(\frac{a\cos^2\alpha}{\sqrt{r^2 - z^2\cos^2\alpha}} + \sin^2\alpha\right) \quad (\text{II})$$

Combining formulas (I) and (II) to eliminate the unknown z produces a formula too voluminous for practical application. To solve a given example, it is much better to assume here, by steps, numerical values for z as 0.1, 0.2, etc., inside the limits O and r, and determine the appertaining y and x from above double equations (I) and (II). In this way the cross-roll may be readily plotted and determined.

Mr. Victor Beutner, consulting engineer, Pittsburg, Pa., read a paper before the Engineers' Society of Western Pennsylvania, December 15, 1903, giving a formula:

$$y = \sqrt{x^2\tan^2\alpha + a^2}\left(1 - \frac{r}{\sqrt{x^2\sin^2\alpha + a^2}}\right)$$

which was derived by his assistant, Mr. Edward Hoefer. This formula is not exact and is only approximately correct; in his derivation, the point of contact is incorrectly assumed on the straight line joining C with F, instead of at point P shown in the diagram. Of course the difference would be small for the ordinary cross-roll problem, not exceeding 3/100 inch on the radius y for cross-rolls with small angles of about 5 to 15 degrees.

* See also MACHINERY, June, 1904: The Manufacture of Pipe, engineering edition only, and July, 1904: Rolls for Straightening Pipe.

† Address: Kenwood St. and Beechwood Boulevard, Pittsburg, Pa.

SHOP PHOTOGRAPHY.*

CARL S. DOW.†

Carl S. Dow.‡

It is customary for a book to have a preface in which the author states his reasons for adding another publication to an already overcrowded supply in that field, or "makes no apology" for bringing it out. A magazine article seldom has a preface, but there is usually just as good a reason for its appearance. What prompted this article was the editorial in the September issue, in which the editors solicited good photographs for illustrations, and deplored the difficulty of obtaining what they want, namely, sharp "contrasty" photographs that make good half-tone plates.

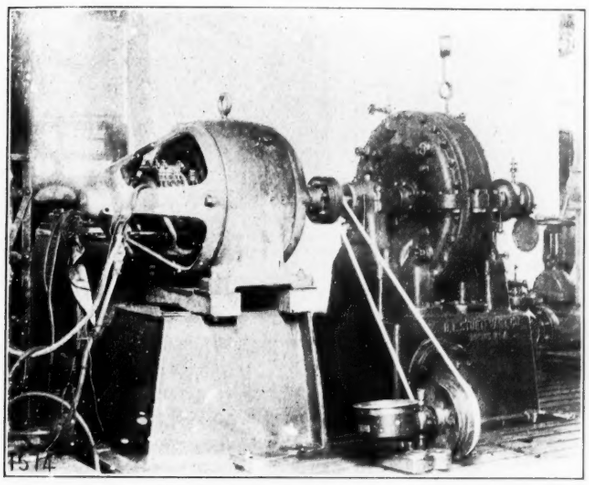


Fig. 1. Photographs taken before Apparatus was Complete. Note the Temporary Base.

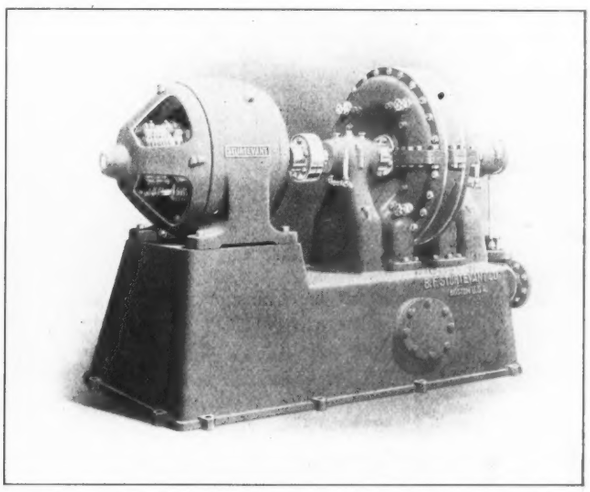


Fig. 1A. A Small Generating Set retouched from Fig. 1. An Expensive though Necessary Picture.

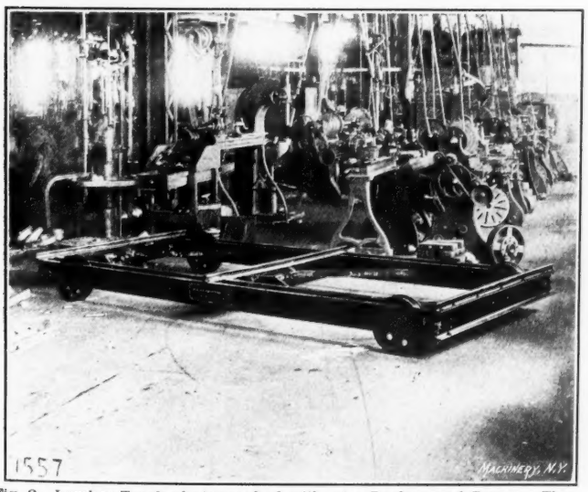


Fig. 2. Lumber Truck photographed without a Background Screen. The Small Stop used brought all Machines into Good Focus.

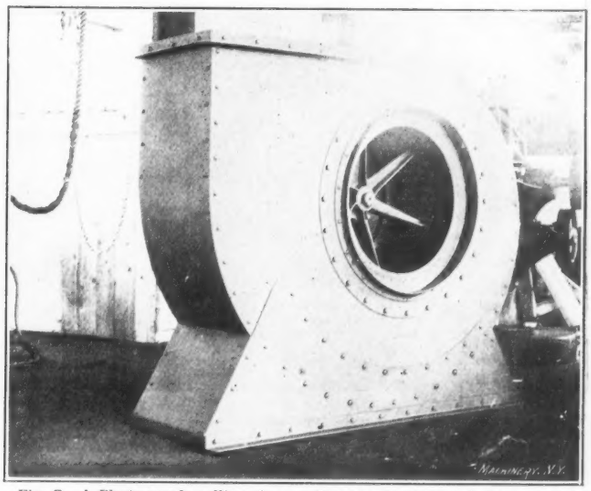


Fig. 3. A Photograph calling for an Opaque Background Screen to prevent Halation from the Windows, and to shut out Surrounding Objects. Otherwise a Good Picture.

It is not for this article to extol the value of photographs as illustrative material, or to tell of the potent influence of good photographs in advertising, but rather to touch upon some of the essential steps in the production of machinery photographs suitable for half-toning.

Practically all photographs for technical illustration are made in the shop; this is especially true of large apparatus or machinery in operation, since in the very nature of things, they cannot be taken to a studio. Small parts, gages, valves, and tools, of course, can be moved into good light without difficulty. The three factors which make satisfactory shop photographs of large machines difficult, and necessitate expensive retouching before engraving, are poor light, crowded condition of the shop, and the unpainted or possibly incomplete state of the machine or apparatus.

Poor light cannot be remedied easily, but the manipulation of backgrounds and screens is often an improvement, and flash powders are frequently of service, especially if certain parts are in deep shadow while the major part of the machine is fairly well lighted. Even if a very long exposure is necessary, natural light is usually preferred to a flash-light. A crowded shop makes it necessary to include other machinery and unfinished material, or perhaps renders the best view impossible. When the shop is so crowded that the photograph cannot be taken from a position that will best bring out the desired parts, or if the machine cannot be moved, the

[The photographs used to illustrate this article were reproduced without retouching or change of any kind save in those cases where otherwise stated. This was done to show clearly the points made by the author, but, incidentally, the unretouched views also give the reader a hint of the work ordinarily put on almost all our half-tone cuts. Most of the photographs were better than those generally submitted, yet the cuts will not compare well with the average of half-tone illustrations used in MACHINERY. We find it necessary to put some retouching on almost all photographs of machinery, shop interiors and similar subjects. If the hints given by Mr. Dow were generally observed the amount of this work would be much reduced and the cuts would gain in snappiness and strength, for a perfect photograph cannot be successfully imitated by the retoucher, although he may be able to greatly improve a poor one.—EDITOR.]

* For previous articles on shop photography see "Shop Photography," by H. P. Fairfield, November, 1906, and "Photographs for Illustration," September, 1907.

† Address: B. F. Sturtevant Co., Hyde Park, Mass.

‡ Carl S. Dow was born at Woburn, Mass., in 1874. He graduated from the engineering department, Harvard University, in 1897, with the degree of S. B. From 1898 to 1905 he was in charge of the text-book department and instruction of the American School of Correspondence at Armour Institute, Chicago, and since up to July, 1907, was in the publicity department of the B. F. Sturtevant Co. He is now advertising manager of that company. Mr. Dow has specialized on engineering publicity and technical editorial work. He has contributed considerably to the engineering press and was editor-in-chief of two volumes on shop-work and of three volumes on practical engineering published by a Philadelphia concern.

making of the negative should be postponed until shipment is made, at which time a better position or light can usually be obtained without much trouble. Obviously a machine should not be photographed until completed and painted, otherwise much expense is necessary for retouching; but of course the negative may be necessary before such state of completion is attained. Speaking of paint—it should always be dull finish, and red, black, or slate color will give good results.

Background Screens.

The probable use for the picture should be known to the artist at the outset. If for a catalogue cut or advertising

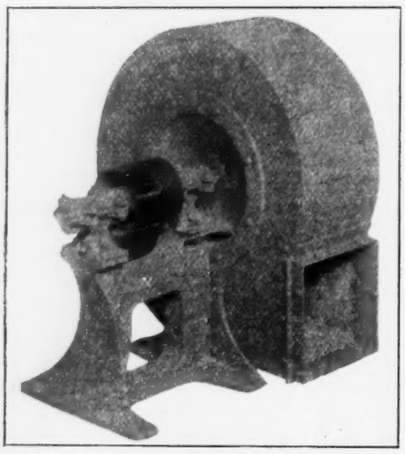


Fig. 4. Made with a Long Focus Lens which was much too High. The Shaft is not Horizontal, the Top and Outlet are Distorted and the Perspective is not Good.

Fig. 4A. Made with Long Focus Lens, with Camera placed at Proper Height. Note the Rectangular Outlet and General Appearance of Good Proportion without Distortion.

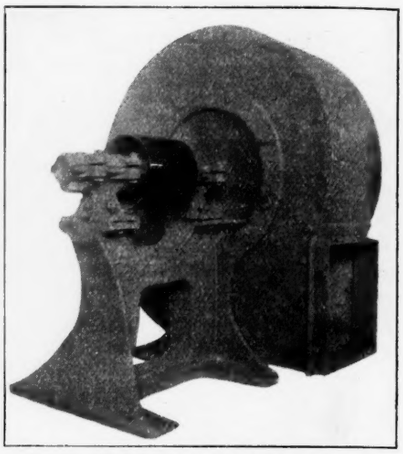


Fig. 4B. Made with a Wide Angle Lens placed at Proper Height. Note the Abnormal Size of the Parts nearest the Camera. The General Effect is Bad.

illustration, the irrelevant machines or material surrounding the object must be obliterated after the negative is made; this is usually done by "painting out" with opaque water color. If the machine has many small parts on the profile, it is often difficult to separate them from the surroundings when painting out. For such conditions a white background

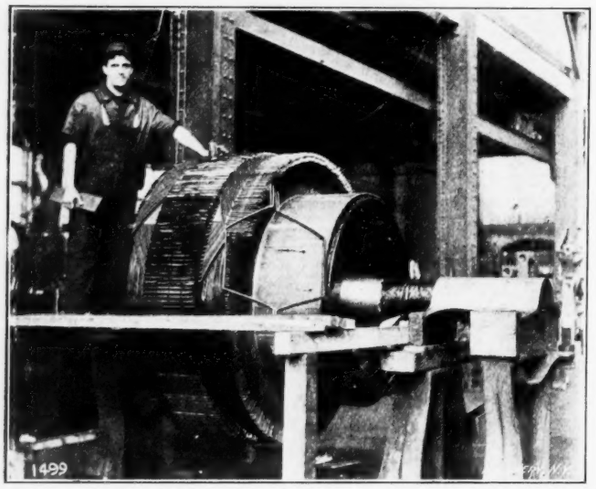


Fig. 5 View in which the Artist had to choose between a Small Stop to get Detail, and a Large Stop to shorten Exposure, so that the Man could remain Immovable.

screen is a great time-saver, for it shuts out the surrounding objects and defines clearly the small parts.

The background screen serves still another purpose. In many shop pictures the desired view necessitates the directing of the camera toward a window, which causes halation around the contour of the machine. An opaque screen will shut off this light which is not only of no assistance in making the photograph but is detrimental. If the background screen is too small to cover the entire machine, it should be placed behind the smallest parts which are the most difficult to paint out. In case no screen is available, the machine should be separated as much as possible from the other apparatus, or placed at some distance in front of it so that the machine only will be in sharp focus. With the light near the floor of less intensity than at a few feet above, white cloth or paper arranged about the bed or frame throws the light upward and brightens up the parts in shadow; it also makes the lower parts more clearly defined.

Position.

In shop photography the features to be brought out are usually those relative to details of construction, or those strongest in selling. The choice of position is one that must sometimes be studied. Shifting the camera a few inches often causes an important detail to become prominent, or, on the other hand, unduly exaggerates a minor or objectionable construction. The writer once had occasion to photograph a blower driven direct-connected by a motor which was large because the air pressure was to be high. Now a good light was easily obtained with the camera in a position that brought the motor into the foreground, but evidently it was not wise to show that the blower required such a large motor because the conditions of pressure might not always be given in connection with the picture. To overcome this, the set was swung around by the electric crane so that the blower came into the foreground, causing the motor to be subordinate to it.

The height of the lens is a point not usually considered with sufficient care, and yet is an important factor in the perspective. One has only to look at two pictures of the same machine to notice the difference. In general, it may

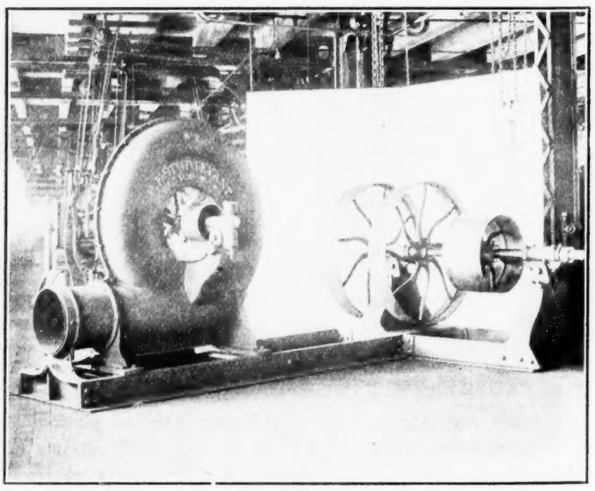


Fig. 6. Showing use of Background Screen too Small to extend over the Entire Apparatus.

be said that the lens should be placed at about the middle of the height, and, if the machine has a horizontal shaft, the lens should be placed on that level. With the lens at or below the center, the machine looks large and substantial, which are often desirable features.

As to the lens itself, a long focus lens should be used, if

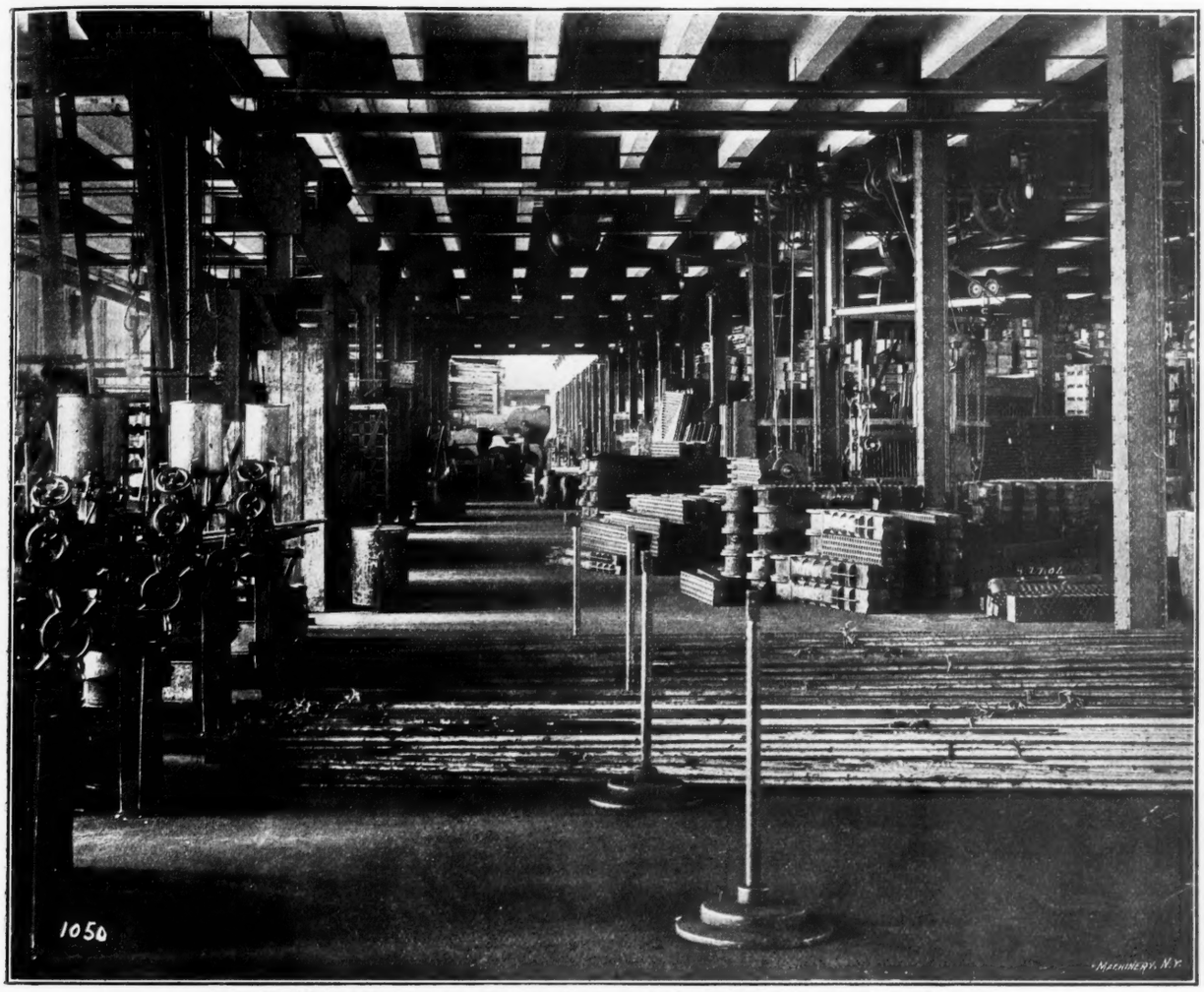


Fig. 7. Well-lighted Shop Interior. The Great Depth required a Small Stop to make all Details Sharp.

possible, when photographing machinery. A wide-angle lens is sure to distort the lines, and make those parts nearest the camera very large; its use should be restricted to cramped places in which it is impossible to get the entire apparatus on the ground glass with a long focus lens.

Focus.

No attempt to focus should be made until the best view has been selected and the camera placed in what is probably the correct position. Focussing is best done with full opening, so that when the opening is reduced the image will be very sharply defined. Curved surfaces are not easily focussed, hence a newspaper, printed sign, or calender, placed against the machine and brought into sharp focus, is a valuable aid. With the black letters in best focus the machine will be sharp.

Stop.

The choice of stop, or opening, must be governed by several conditions, and here is a chance for one to use his judgment. A small stop requires a long exposure, gives a sharp picture, and brings all parts of the apparatus into focus. This last point should not be overlooked, if the distance from the camera to some points of the machine is far greater than to others. When all of the machine lies in the same plane, a large stop will probably give as good a picture, and the exposure will be of much shorter duration. To get the detail

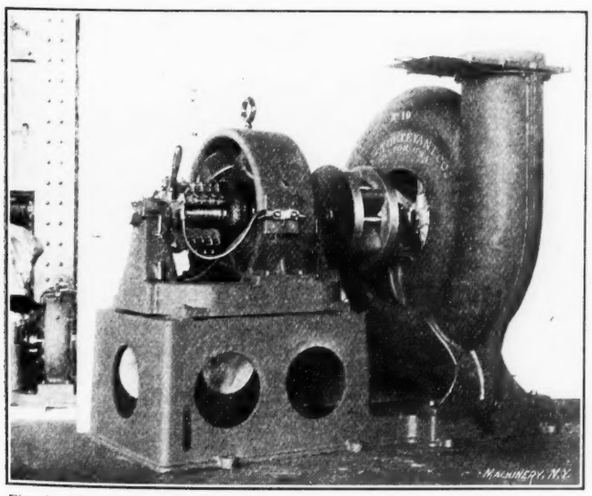


Fig. 8. Illustrating the Use of a Small Stop and Long Exposure. In a Well-lighted Shop about 30 feet from the Windows, at Noon, the Exposure was Seven Minutes, Seed 26 Plate, and F64 Stop.

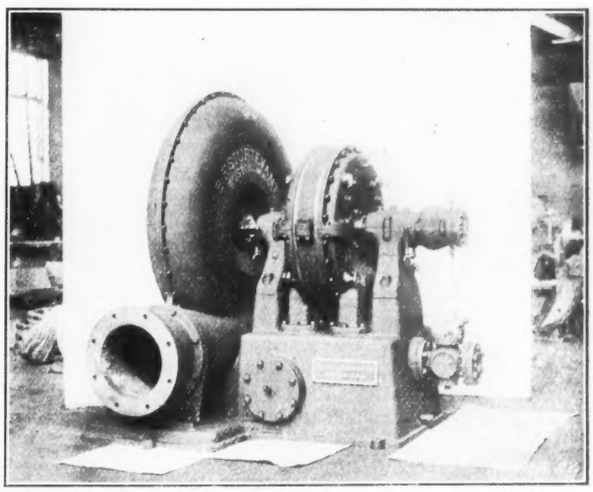
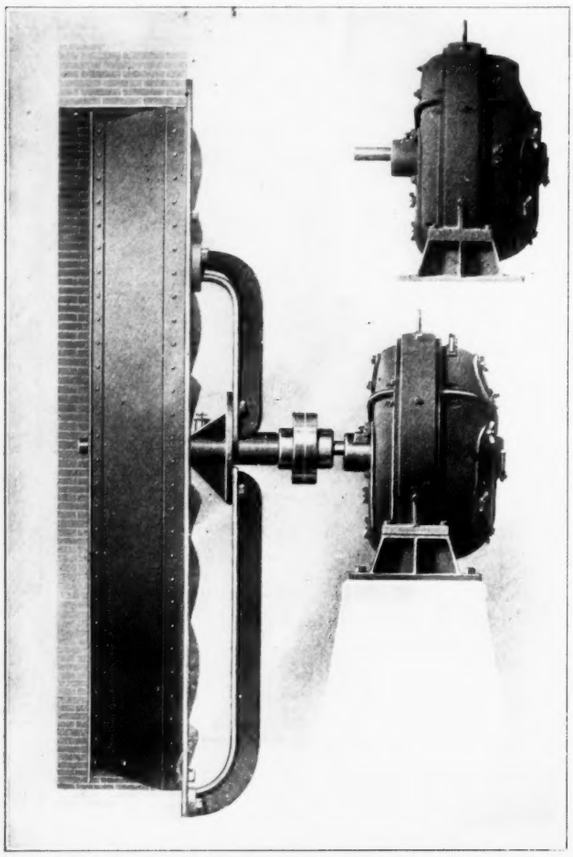


Fig. 9. Under Saw-tooth Roof at Noon, Exposure Seven Minutes, Cramer Banner X Plate, F32 Stop.

of small parts, such as the armature of a motor, a small stop is desirable. It sometimes happens that a small stop is out of the question, for a very long exposure (15 minutes to one-half hour) would prevent the men in the shop doing their work, or might delay passing to and from machines. In general, it may be said that the stop should be as small as conditions will allow.

Exposure.

The length of time the plate should be exposed is determined solely from experience and a knowledge of conditions.



Figs. 10 and 10A. Photograph of Motor to be combined with Wash Drawing, and the Result. The Photograph of Motor was Retouched to make it blend with Drawing.

It is almost useless to give any figures, for the light varies, not only in different shops, but in the same shop, according to the season and time of day. The size of the stop and the speed of the plate are also controlling factors. Under-exposure is far more common than over-exposure. In a well-lighted shop at a distance of 10 to 20 feet from the windows, with a "Seed 26" or "Cramer Crown" plate, and a small stop, 3 to 8 minutes is usually required. The writer finds a moderate speed plate, such as a "Cramer Banner," very satisfactory, for it has considerable latitude, yet is not so slow as to consume an excessive amount of valuable time.

Exposure is a most important part of photography. The length of time may perhaps be easiest determined by comparing the existing conditions with those under which a satisfactory negative has been made. This determination of exposure is unconsciously followed by everyone. To make the comparison easy, the same size of opening and the same kind of plate should be used as much as possible.

A machine with few polished parts, and painted black, or the armature of a motor, requires a long exposure. When in a bright light, polished parts may show undesirable reflections, but the parts may be given a frosty appearance by dabbing them with putty, which can easily be wiped off with benzine or gasoline. Lettering, such as the maker's name, and the size of the machine, can be well brought out in a photograph by chalking just before exposure.

Developing.

The procedure of development, and the kind of developer to use for negatives made in the shop, are not different for negatives made elsewhere. Almost the only consideration is the printing quality. In any large manufacturing plant, the advertising or sales departments may make a rush call for a large number of prints from a certain negative. Unfavorable weather may render it impossible to get the prints off for several days. In plants of this kind, the developer should be so selected, and the depth to which the development is carried should be such, as to yield clear, quick-printing negatives. Over-exposure should be avoided.

Pyro is deservedly a favorite with many, because of the ease with which slight errors in exposure may be counteracted. But its liability to spoil, and cause stained or slow-printing negatives, has led some to discard it. Pyro developer will be preserved indefinitely by dissolving a small quantity of oxalic acid (10 grains to 16 ounces) in the water in which the pyro is to be dissolved. The oxalic acid should be dissolved before the pyro is added. All stains may be eliminated by using a little acetic acid in the hypo bath (1 ounce to 1 quart of water).

An intelligent manipulation of the developer requires experience and some knowledge of chemistry. Probably the most common difficulty is that of getting negatives with contrast, for the shadows often show too much detail where there should be practically clear glass. To print such negatives to sufficient depth to make these shadows strong, causes the high lights to become dimmed. If the exposure has been properly timed, the cause of excessive detail in the shadows is probably too much sulphite of soda (in pyro developer) or too much alkali. A reduction in the amount of alkali will almost invariably effect an improvement.

Printing and Paper.

The photographer may receive orders for prints of any one of three kinds—blue prints, silver prints, or developed prints. For general sales use, the blue print is widely used, for it is

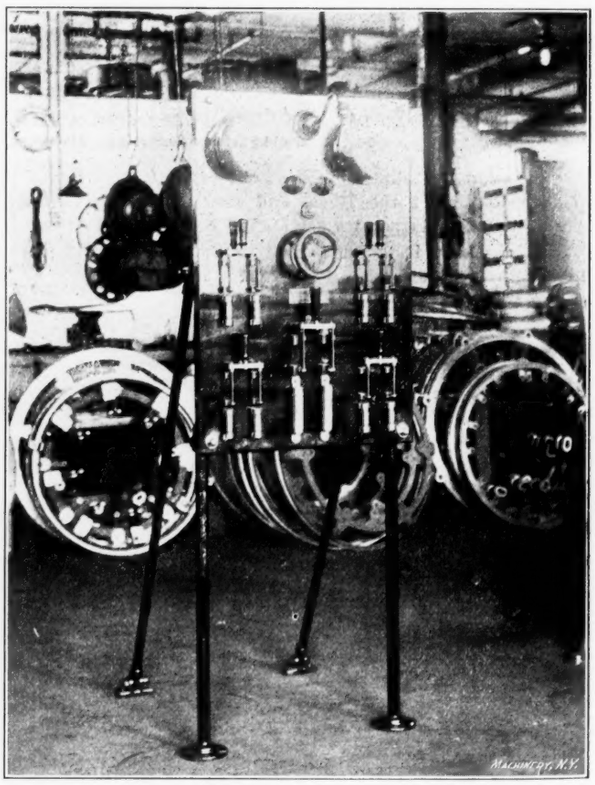


Fig. 11. Carelessly-made Photograph. Intense Direct Light from Windows caused Over-exposure and Reflection at top of Switchboard. The Lower Part is Good. Windows should have been Curtained.

quickly made, inexpensive, can be folded without cracking, and is of a businesslike appearance. It is well to purchase the prepared stock in metal tubes; being of higher grade it will yield far better prints than the cheaper blue print paper used for making shop prints from tracings.

The silver print is by far the best for retouching and half-toning; it gives the detail and smooth surface necessary for these processes. When making a print for half-toning, it

should not be too dark in the shadows, and the tone should be of a good chocolate. A deep brown tone is superior to a blue or purple, which photograph lighter. Yellows and reds should be avoided. In mounting a print for retouching, the cardboard should be thick to prevent warping, and very smooth. The smoothest card possible is the only suitable board for mounting.

Machinery salesmen frequently want their prints mounted on cloth so that they will stand the wear and tear of constant use; the cloth also provides a means of binding. Cloth-mounted prints are often ferrotyped, that is, given a glossy surface which adds to both appearance and durability. This finish is obtained as follows: The wet print is placed face down on the ferrotype plate, which has been made scrupulously clean and lubricated slightly with soap or glycerine. After removing all bubbles, the back of the print is covered with paste and the cloth pressed in contact with the print. When the print dries the corners will start from the ferrotype plate, from which it may easily be stripped when perfectly dry. It is then trimmed, the strip of cloth or binding being left on the proper edge. Velox or other gas-light prints, except with certain grades of paper, have too rough a surface for retouching. They are more "contrasty" than silver prints, and show less detail. For framing and for rush orders, they are very satisfactory for they can be turned out rapidly, even if the weather is cloudy, or if the short days of winter are at hand. A negative that is too thin, in other words, a "flat" negative, will yield a better print on a gas-light paper.

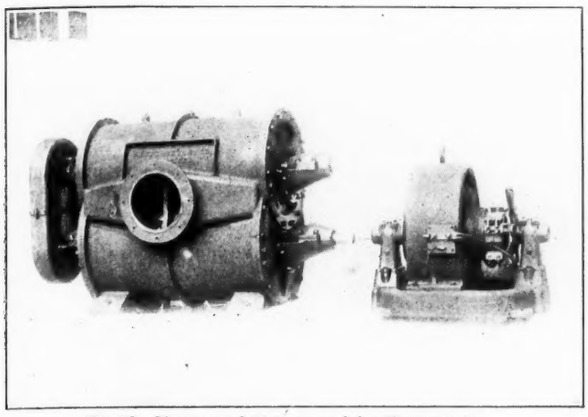


Fig. 12. Blower and Motor posed for Photograph.

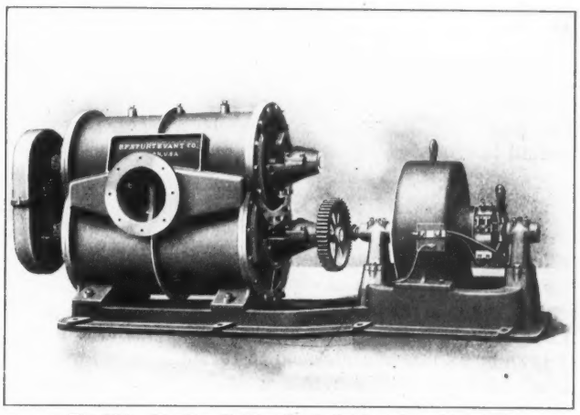


Fig. 12A. The Result after the Artist has done his Work.

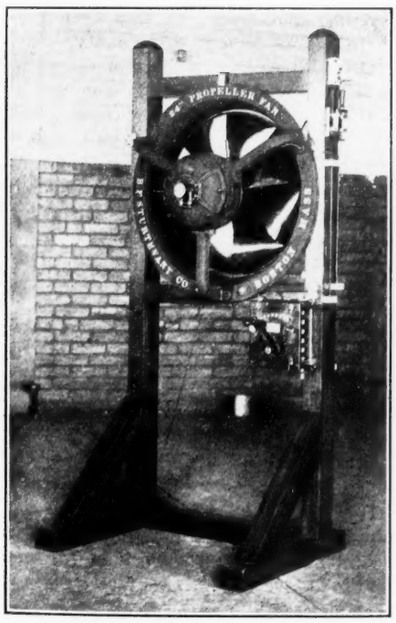


Fig. 13. The Motor-driven Fan and its Controller.

Fig. 13A. The Picture of the Child.

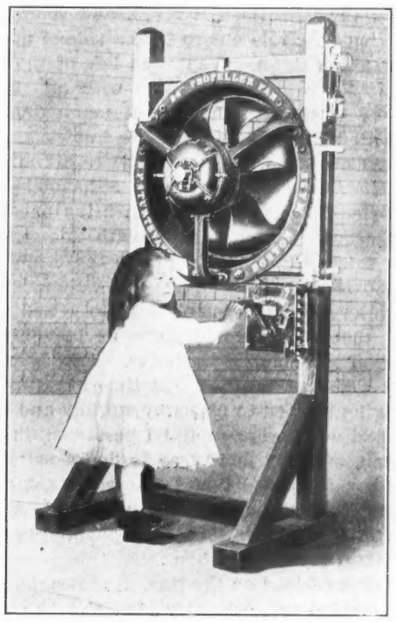


Fig. 13B. The Result of the Combination.

"Faking" or Altering Photographs.

In certain lines of work existing conditions render it impossible at times to get the machine photographed just as it is wanted, or perhaps an effect is desired, which, although reasonable or probable, is out of the question. Innumerable cases of extensive alteration, even to the extent of "faking," might be described, but three will serve as examples.

In preparing a publication on electric propeller fans, the writer was unable to photograph a large fan of certain constructive features, for at the time none was in stock and no order was going through the shop. To get the complete photograph of the motor-driven fan, as shown in Fig. 10, a photograph of a motor of the proper type and size was first made. This was painted out and printed on a 10 x 12 sheet of silver paper. An outline drawing of the propeller fan of the correct size for the motor was then made in pencil on the mounted silver print. The artist had no difficulty in placing the concrete base beneath the motor and making a "wash" drawing of the pencil outline. The illustration is worthy of note in that the motor is an actual photograph, while the fan, brickwork, and motor base are not.

A case illustrating the necessity of photographing machinery before it is complete is shown in Fig. 12. The writer needed a picture of a motor-driven rotary blower before the set had been built. A motor of the proper size to drive the blower at hand was placed in position. The relative speeds being known, the pitch and diameter of the gears were easily determined, and the pitch diameters gave the distance between the shafts. Of course no bed or foundation was at hand so that it was necessary to build up the blocking to the desired height. By the means of the electric crane, the motor was placed with the shaft parallel to that of the blower and at the proper distance from it. To make the painting out easier, the blocking for both blower and motor was covered with white cloth, and two background screens were used. The

artist painted in the bed from the working drawings (the patterns not yet being made) and also the gears.

It may strike some readers that the child photographed in the act of starting the electric propeller fan is out of place in a shop photograph. The picture is, of course, designed to show the simplicity of operation. This effect was produced from two negatives. The fan itself in the supporting frame was photographed in the shop, with an exposure of about seven minutes, and the child was photographed in her home against a dark background, with her hand resting on the corner of a table, the height of which approximated the height of the rheostat handle. A double printing and a little artistic work completed the picture. A point to be remembered in this connection is the height of the lens. If the lens had not been at practically the same height in both cases, the child's feet would have had an incorrect perspective.

* * *

BILL'S GARAGE.

ETHAN VIALL.*

My friend Bill and I often get together after the day's work is over and swap stories and experiences. Bill is the superintendent of the general hardware factory just across the street from our shop. His experience has been wide; he is a hustler, and knows how to handle his men to the very best advantage.

One evening our talk ran into a discussion as to whether a man was better off working for himself, or in getting and keeping a good job with some reliable firm. The talk waxed rather warm, and Bill was so positive in his stand that a man was better off working for someone else, that I finally said, "I'll bet a five-dollar note that you've been burnt, yourself." Bill rubbed his head, and, with a rueful smile, replied, "Yes, I have been burnt, and not only that but burned out, and only three or four years ago at that."

He paused to throw away the stub he had been smoking, and, lighting a fresh cigar, he said, "After several years of successful running of shops for other people, I became imbued with the idea that I could do better in business for myself. At that time the boom of the bicycle business, which had furnished work for so many 'mushroom' repair shops and 'toadstool' mechanics, had died out, and the automobile was just passing the experimental stage, and coming near enough to perfection to enable one to take a ride of at least a mile without breaking down. What was left of the bicycle trade had settled into a steady business with all the flourishes gone. Now my work with the largest manufacturer of bicycles in the United States had given me knowledge of 'kinks' in the business unknown to the average repair man, and I also had an intimate knowledge of the automobile shop work as it then existed, owing to this firm being one of the first to get into the new line. Naturally, with this experience still fresh in my mind, my thoughts ran to the establishment of a general repair shop for bicycles and automobiles, and then perhaps later on an automobile factory and a position in the 'trust' that I felt would come as inevitably as Col. Pope's corner of the bicycle factories. (Teddy the 'trust buster,' hadn't begun to 'bust' at that time.)

"Having decided to place my worldly and mechanical knowledge, and what other capital I possessed, in an automobile, so to speak, my next move was to find a suitable town to settle in, as I had decided that I wanted to get out of Chicago for a change. About half way down the state was an enterprising little town of thirty thousand inhabitants, which seemed to be an ideal place for a shop.

"Having decided on the line, the town, and finally the building, I started to work. My plan was to begin modestly and build up my trade gradually. Dropping the auto repair idea for a time, I devoted my energy to the bicycle business. There were five other shops in town but I could vulcanize tires and do brazing, which they could not, and, using these two accomplishments as drawing cards and headings for my advertisements, I soon had enough business to keep myself and two men hustling. The growth of my trade was really phenomenal, which I attribute to thoroughly knowing my business and to advertising. I advertised in 'catchy' ways in every city and county paper, and on the fences at every cross road.

"In addition to my repair work, my sale of supplies began to assume really respectable proportions. I had started early in the spring and by fall my business was far beyond my widest hopes, but, fearing a dropping off of business due to the stopping of bicycle riding at the approach of winter, I added another line—barber supplies.

"There were thirty-four barber shops in town, so I left my repair work in the hands of my men, and personally went after the job of supplying these shops with everything they used, from face powder and soap, through the different shapes of combs and shears, to chairs and fixtures. I had three big Chicago supply houses to 'buck against,' and also one from a neighboring town, but before the winter was half over I was selling nine-tenths of the stuff used by the barbers in town, and was reaching after the trade in the little towns nearby. As spring approached, I moved to larger quarters, and, still keeping my grip on all I had gained, I began to pull for the

"One night the whole business went up in smoke."

automobile trade for all I was worth. I had but one rival in this, but it was a formidable one, as this firm had sold practically all the automobiles used in the county, which, at this time, numbered about sixty. Nevertheless, with the prestige I had gained in my other work it was but a few months when the bulk of both the repair work and the selling of automobile supplies was mine. All that year my business grew until I was unable to handle all of it, and I sold my bicycle business to one of the other shops, and devoted my energies to the barber supply and automobile business. By the following spring, having added the agency for two popular automobiles, I had one of the best equipped garages in the country for a town of the size I was in. I carried about two thousand dollars' worth of supplies on hand, and, in addition, tools, machines and other things that brought the total up to about five thousand dollars, which, owing to the nature of the business, was all risk and no insurance, and one night the whole business 'went up in smoke,' or at least most of it, for the stuff that was left was hardly worth sorting over. A big twelve-horse-power gasoline engine which I had just installed to furnish power for my machine shop, brought five dollars for junk!

"Tired and discouraged by a misfortune that had cost me the product of two and one-half years' work and about six thousand dollars, I turned over my trade to the man who had bought my bicycle business, and securing a position as superintendent of the hardware factory, I went out of business for myself, but though my financial loss was considerable, yet I count the experience a valuable asset.

"I have no desire to go back to working for myself where I have to get up at half past four in the morning and work till midnight, with no Sundays or holidays. I much prefer to run some other man's shop, where, while I do my best, it is someone else who has the worry over the bills, the payroll and the business, and if anyone thinks that running one's own shop is a snap, let 'em *try* it."

Then Bill got up and we both started for home.

* Address: 805 N. Mercer St., Decatur, Ill.

SAFEGUARD IN MACHINERY.

W. H. BOOTH.*

In Great Britain, and probably still more in Germany, the care of the workman is apt to be more rigid on the part of the government than it is in perhaps any other countries. In the opinion of many people who have watched the statistics of accidents, the effect of this care has been largely nullified in Great Britain by the countervailing influence of the Employers' Liability Act, which provides compensation for a workman, irrespective of whether the accident was due to his own wilful disobedience of safety rules or not. It may seem curious that personal injuries should increase as a result of certain compensation. It can scarcely be believed that any man would wilfully injure himself, and one can only attribute such increase of injuries to the unconscious effects of the acts for compensation.

But it is certain that workmen do take extraordinary risks without being called on to do so. Often one may hear an employer blamed because some poor fellow has gone home crippled, in order to put gold into his employer's pocket, but, careless as some employers may be, it is true that the workers are more often to blame than their employer. Men will dip under a suspended weight to save an extra yard in going round it. They will risk their own lives and their employer's solvency for the sake of a trivial economy of time.

The writer was once forced to lower a weight with tackle not safe for half the load put upon it. All hands were called clear, and the extreme danger pointed out, and yet men would pass beneath the load in this dangerous condition, and it was useless to attempt to stop them. If every one were to detail his experiences of carelessness, it would seem that some men cannot be trusted to care for their own lives or for those of others. They do not mean to be hurt; they simply think it will be all right this time, and probably say to themselves "for the last time," resolving not to do it again, and they do this once too often.

Among the inspectors of the Home Office, which is the department of the English government that cares for these things, nothing is left to chance. Often more is enforced than ought to be, for one is sometimes compelled to place fences so that they add to the danger, as when placed too near to a small gas engine fly-wheel, so that it is difficult to start the engine by the usual method for small engines, namely, by turning of the fly-wheel. Probably, in time, no gas engine will be allowed to be started except by an accumulated air pressure. Wheels are guarded very completely. A pair guarded only on their top or in-running sides were ordered to be fully cased in because "some time it might happen" that in some extraordinary way they would turn the other way round.

Machinery fencing is of two sorts. There is the guard over the pair of wheels or other detail, and there is the general guard or fence or cage which contains the whole machine and prevents all access to it except by key. Some things cannot be guarded, such as the cutters of certain woodworking machinery, and these are perhaps the worst things for accident producing, for they are almost invisible when most dangerous. A circular saw might often be better caged than guarded, but a saw may be very considerably protected by a distance guard, when it is impossible to guard by a close cover. The Home Office takes account also of child labor, of overtime for women and young persons generally, of heating, lighting, ventilation, and sanitation, and especially of the precautions to be adopted when persons are employed, as in the glazing of pottery. All pottery people are on the *qui vive* to find a leadless glaze. One hears of leadless glaze, but investigation generally reveals a hidden source of lead. The trouble comes in the putting on of the glaze in solution, and all the evils of lead poisoning accrue, so that a strict watch is kept on all who are employed in respect of medical examination for detecting the first symptoms. Yet people who know they have symptoms will endeavor to hide them, and pass the doctor. Fans, for removal of dust, and all manner of respirators and other safeguards are more or less attended to by Home Office inspectors.

*Address: 25 Queen Anne's Gate, Westminster, S. W., London, England.

In the pottery trade, the scheme was tried of putting hoods over the heads of the workers, into which fresh air from an absolutely pure source was brought, so that there should always be a draft away from the workers and lead fumes could not get toward them, but somehow this did not answer. The lead taken into the system is not all taken through the lungs. The file cutter who cuts his files upon a block of lead is often careless how he eats food with leaded fingers, and lead will get into the body through the skin.

Copper poisoning does not appear to attract the same attention as lead, but undoubtedly brass workers suffer in health as a result of the copper. A brass founder never has any infectious complaint, it is said, for copper fumes are fatal to germ life, and, finally, are fatal to the man, but the effects are not so painful as those of lead, possibly because the copper salts are soluble and are eliminated, whereas lead accumulates. Brass workers appear to develop a dislike to fresh air. They will not put up with open windows that other men can enjoy, so that a brass shop ought to be fitted with a ventilation system out of the control of the occupants, and should be suitably warmed to fit the enfeebled workers, who might then be much improved.

One of the reasons why Kaffir labor becomes so scarce in the Transvaal mines was alleged to be the extraordinary high pay given to the "boys" during the war. But probably a much more potent cause has been the discovery by the Kaffirs that working rock drills produces miner's phthisis, so that the men died like flies, and now fight shy of mining work. The drills ought to work through an exhausted hood piece, the dusty air being delivered through a water box to settle out the grit. The provision of good water has been shown to be a great help in keeping machinery going. Good air is equally valuable.

Every industry has its own peculiar crop of accidents, from unexpected directions and least suspected causes. It almost seems necessary for accidents to happen in order that weak points in design may be shown up, just as the true stresses in machinery and structural work only show up in actual work, though this is less the case now than formerly when the failure of bridge details began to teach men that they could not allow the same nominal unit stresses in all details, but must take account of the manner of approach of the stress-producing agent or load.

Familiarity may lead to accident. It may also serve to prevent accident. Thus, if the people of England began to-morrow to walk upon the tracks of a railroad in the way usual in America, many thousands would be killed. In a week's time very few would be even hurt. So it is with ordinary machinery. The worker does not get hurt so often as might be thought likely, but, nevertheless, he does sometimes suffer from lack of guards to the more dangerous parts. The knowledge of what to guard, and how to guard it, is quite a special knowledge, demanding acquaintance with the machine and the method of its operation, and a general acquaintance with machinery and with accidents of all kinds.

* * *

The Stockbridge Machine Co., of Worcester, Mass., has its shop in a building that is not as well suited to the needs of a modern machine tool manufactory as it should be, but by adaptation it has been made to serve the purpose fairly well. Not long ago a Gisholt boring mill was purchased, and its logical location to suit previous steps of manufacture was on the second floor, but the floor would not safely permit the installation of this 11,000-pound machine without considerable strengthening. Instead of doing this, and perhaps getting an unsatisfactory foundation after all, it was decided to build a foundation up from the ground through the first story. This might naturally be thought expensive, but it proved otherwise. The column erected was 3 feet 4 inches by 5 feet 4 inches by 16 feet high. It was constructed of concrete, mixed as follows: Cement, one barrel; sand, two barrels; gravel, ½ cubic foot; and broken stone, 9/10 cubic foot. The center was cored, leaving walls 8 inches thick, and a door was set in one side, thus making the inside of the column available as a fireproof storage vault. The cost of the material was but little over $30.

NOTES FROM THE OLYMPIA EXHIBITION.

JAMES VOSE.*

The engineering and machinery exhibition at Olympia, London, is chiefly representative of machine and hand tools, though many general engineering exhibits are on view. An advisory council, representative of leading engineering associations, manufacturing establishments and commercial institutions affords valuable aid to the organizers, while the educational aspect of the show is kept well in view, special facilities being afforded engineering students to visit the exhibition on organized lines under specially appointed guides. Arrangements also have been made, of which considerable advantage is being taken, for workmen to visit London and the show at a very low cost, while a number of interesting lectures are being given by experts in various branches of engineering.

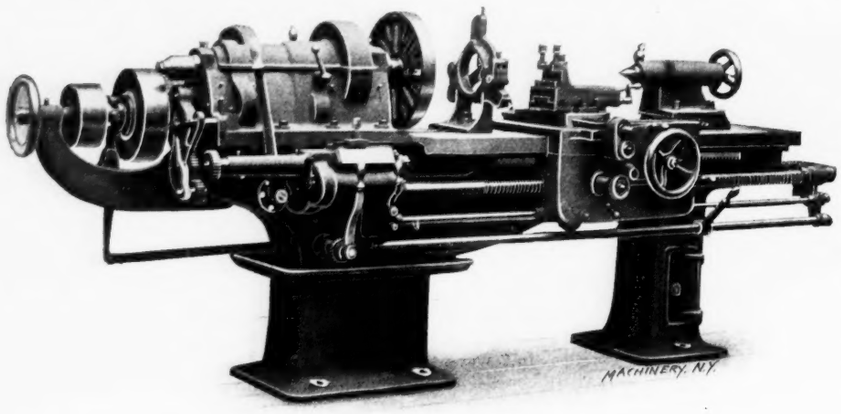


Fig. 1. George Richard's High-speed All-gear-drive Engine Lathe.

Touching on tools particularly, a striking feature is the cosmopolitan character of the exhibits, and the wide distribution of manufacture of types of tools which until recently appeared to be entirely confined to a few pioneers of well-founded reputation. Another noticeable development, emphasized by the exhibits, is the extent to which merchants formerly, by force of circumstances, almost exclusively identified with American tools, now—without in any degree relinquishing their handling of American lines—have taken up British and Continental productions. At the same time, in some cases, the special insight they have gained into the requirements of customers has enabled them to evolve lines of their own which they have commissioned various makers to manufacture for them.

The cutting of spur gears by the process of hobbing appears to have made rapid advances in Europe, quite a number of such machines being shown in operation. We noticed examples built or handled by Reinecker, Biernatzki, Holroyd, Burton-Griffiths, Selig-Sonnenthal, Humpage, Thompson & Hardy, and Henry Wallwork. So far, we have not actually seen an American contribution, though rumors are afloat as to such being under way. (See MACHINERY, October and November, for examples.) New builds of plain or universal precision grinding machines, presenting novel features, are identified with the Newall Engineering Co., Macdonald, Adamson & Co., Ltd., and the Morse Co. The requirements of automobile builders are extensively catered to, crank-shaft lathes, cam grinders, grinders for finishing square holes after the hardening process, cylinder, piston ring, and valve grinders, etc., being prominently in evidence. No lack of choice is experienced in electrically and pneumatically worked portable drills, grinders, etc. Constant-speed belt-and gear-driven lathes, drills, etc., are met with at every turn, though here and there the opinion is expressed that the application of this principle is in some danger of being overdone, and that well-designed cone-driven tools are by no means played out.

In passing, mention may be made of the additional weight provided in American tools, and the increased handiness in manipulative details of current British tools. Judging by the widely-differing types of metal-sawing machines on view, the subject of rapid and economical cutting up of stock is attracting increased attention the world over. A feature of the last year or two is the number of pipe-bending appliances brought to the notice of users, and this tendency is reflected in the variety of machines exhibited, capable of dealing with tubing of the most varied strength and diameters. Some are worked by lever or worm and wheel, while others are hydraulically worked. In some instances, the tubes are filled during bending, and in others this is unnecessary. Although the idea and use of high-speed steels of modern types was introduced from the United States, the large number of British exhibits of such steels, and the articles manufactured from them, contrast rather remarkably with the paucity of American products in this line on view. The high duty imposed on tool steel entering the United States is perhaps not unconnected with this feature of the situation. The show of turret lathes and automatic screw machines is quite comprehensive, the novelties of a few years back being non-accepted standards, and exploited by quite a number of new makers. The systematic grinding of cutting tools has made considerable headway in Europe during the last few years, and a good show of machines for accomplishing this object is to be seen. Many of them have been distinctly influenced by American designs. Several relieving lathes of continental origin, for the production of formed cutters, etc., are shown. It is rather curious that no American or British firm makes this a "leading line." Boring and turning mills are pretty well in evidence in the smaller sizes and also upright drills of the light and medium varieties. A few radial drills are shown, perhaps the most prominent being a Bickford constant-speed belt machine, and a Kendall & Gent double spindle machine also driven by a constant-speed belt. The specialty of the latter machine lies in the fact that one spindle is used for drilling, the other for tapping, and that the saddle carrying them may be instantly moved the required distance for interchanging their positions. Rapid and accurate tapping

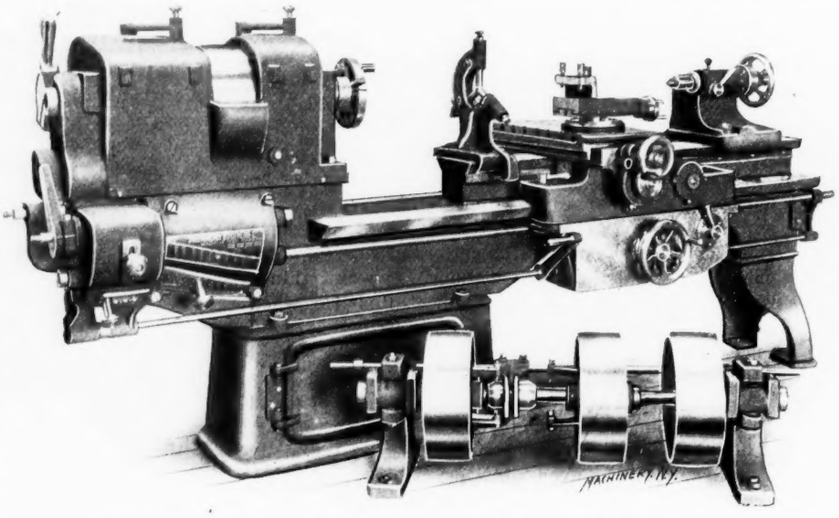


Fig. 2. Drummond Bros. 18-inch Swing Patent Gap Bed Engine Lathe, All-gear-drive.

* Address: 100 Ayres Road, Brook's Bar, Manchester, England.

is thereby assured, the tapping spindle speed being always correctly related to the drilling speed, though the tap is backed out quickly. Bolt and pipe threading machinery is well represented, the American Landis machine attracting attention by its special form of die, while the "Helios" is a continental

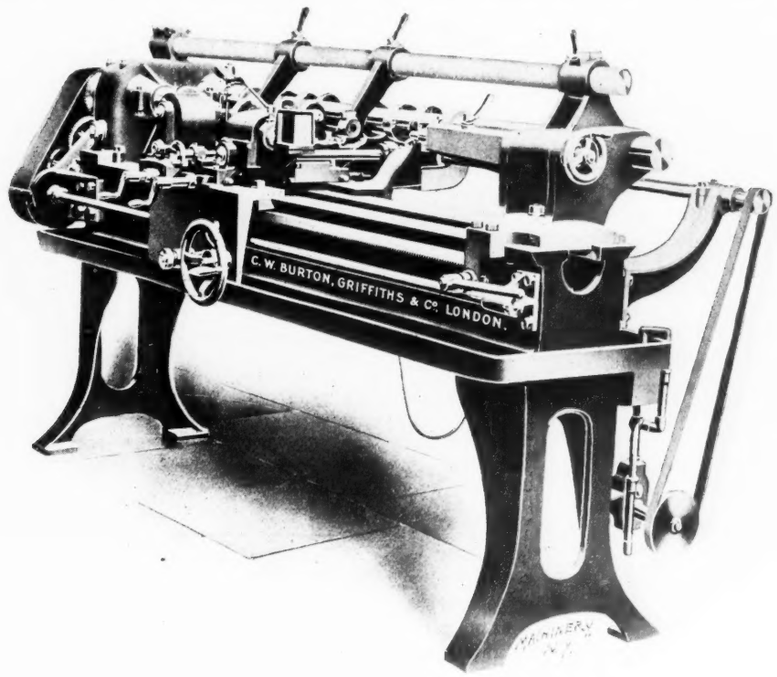


Fig. 3. C. W. Burton-Griffiths & Co.'s Milling and Grinding Machine for Gas Engine Cam Shafts. Cutters and Emery Grinder controlled by Cam Shaft at Rear.

type possessing a number of good features. Substantial typical British machines are shown by Joshua Heap & Co., and Kendall & Gent.

Lathes specially adapted for repair work, in sizes from 7 inches swing to 18 inches swing, are presented by Drummond Brothers, who obtain the advantage of a gap bed while retaining efficient guidance of the saddle by making the sliding ways of the bed in line with the bottom of the gap, the tailstock only being guided by the upper portion of the bed.

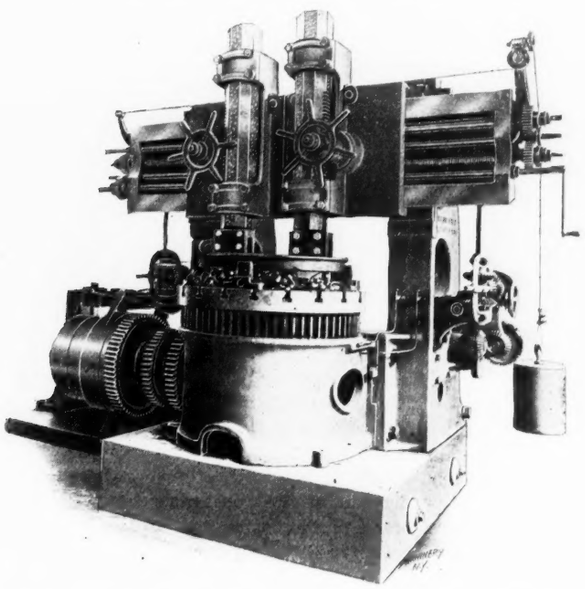


Fig. 4. Smith & Coventry, Ltd., Vertical Tire Boring Mill. Capacity, 42 inches Diameter and 9 1-2 inches Deep. This Mill bored a Siemens-Martin Steel Tire, 31 3-4 inches Outside Diameter, in Six Minutes. Cut, 1-4 inch Deep, 1-8 inch Feed.

The 7-inch swing lathe is powerful enough to reduce a 1⅛-inch steel spindle to ⅞ inch diameter at one cut, or to take a cut ¼-inch deep off a cast iron disk 9 inches in diameter. The saddles of these lathes are arranged to form a tee-slotted boring table—the top slide being quickly removed—well adapted for such repair or new work as motor car cylinders, gear case boring, etc.

In the miscellaneous section, a novelty is the "Dreadnought" file, which has deep semicircular teeth, (see MACHINERY, March, 1907), and is called a milling file, as the cuttings come off in distinct shavings. It is claimed to cut two or three times faster than an ordinary file. A supporting back is used in conjunction with the file. A special feature is its self-cleaning action, which is very marked, and though the teeth are coarse, the surface produced is unusually smooth. It can be resharpened about four times at about half the cost of recutting an ordinary file. The statements of the makers appear confirmed by actual tests at the company's stand, though, of course, fairly prolonged trials will be necessary to obtain data applicable to regular workshop conditions. The show of bevel gear planers is very representative, and includes Bilgram, Reinecker and Zimmerman types, the latter employing two tools simultaneously. The shape of tooth is governed by a former, and a single form controls both tools, thus securing similarity of both sides of the tooth. Taken altogether, the show of machine tools and accessories is probably the most representative ever held in Great Britain, and has attracted visitors from many countries.

The preceding notes only purport to give a general idea of the scope of the exhibition, anything approximating to an adequate description of all the interesting tools would take up the major portion of this issue, but sufficient data have perhaps been

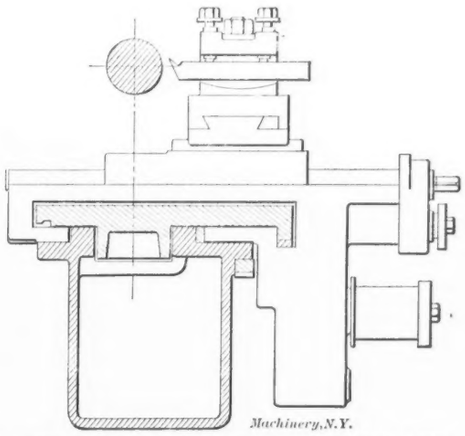


Fig. 5. Cross-section of George Richards High-speed Lathe, shown in Fig. 1, showing Construction which protects Bearings of Bed and Carriage from Chips.

brought forward to indicate its value from educational, engineering and commercial standpoints.

* * *

The development of the shop operation sheet idea, which, by the way, we believe is an entirely new feature in trade journal literature, should bring out methods in machine shop practice that heretofore have been generally overlooked or regarded merely as a matter of course, and we hope to receive the hearty coöperation of our readers in the presentation of what are regarded as standard methods, even though they may be regarded as in the A B C's of the machinist's art. It may be a matter of surprise to some to learn that the preparation and editing of this matter, simple as it looks, is the most difficult of any that we have ever handled. But if any reader has any operation sheet to suggest, he should not let this fact deter him from sending it in and letting the editors wrestle with it, for that is *our* business.

ON DETERMINING SIZE OF FLY-WHEELS FOR MOTOR-DRIVEN PLANERS.*

W. OWEN.†

W. Owen.‡

The question of motor driving for high-speed planing machines brings forward many interesting problems, among which the ascertaining of the correct dimensions for the fly-wheel is not the least.

I read, some time since, in MACHINERY (June, 1905), an article on motor-driven planing machines by Mr. A. L. De Leeuw, in which the writer mentions that he discerns something of a joke in the contemplation of a fly-wheel in combination with a compound-wound motor. Now I, for one, quite fail to appreciate this joke, and always advocate the use of this arrangement for planer driving for the following reason:

The primary function of a fly-wheel is not so much the preservation of a constant speed, as Mr. De Leeuw suggests, as the relieving of the motor from excessive shock at the instant of reversal.

A shunt-wound motor tends to keep the same speed at all loads, but must necessarily slow down for a moment, however large the fly-wheel, at the instant of reversal, thus tending to spark. Of course, the larger the motor, the greater the store of energy in the armature, consequently the smaller the drop in speed and less tendency to sparking, hence Mr. De Leeuw's preference for a *large* shunt-wound motor.

A compound-wound motor, on the other hand, will drop slightly in speed under heavy loads, the percentage of drop, of course, depending upon the amount of compounding. It is this property of the compound motor which enables the fly-wheel to perform its work satisfactorily. A correctly designed fly-wheel will, at the moment of reversal, keep up the speed of the motor slightly higher than that corresponding to the load on the motor at that instant, thus eliminating all possibility of sparking.

Now the determining of the dimensions of the fly-wheel before the machine is made, to fulfill these conditions, necessitates close scrutiny of the engineering press, so as to be continually cognizant of tests taken at different times on high-speed planing machines. A better method, where practicable, is to test the machine before deciding upon either the motor or the fly-wheel.

A machine recently tested under the latter condition gave the following: Average horse-power cutting, 19; average horse-power backing, 11. At the instant of reversal to backing stroke the ammeter needle jumped to 190 on a 220-volt circuit, showing maximum horse-power to be about 55, and the time taken up from the table striking the dog to the attainment of maximum backing speed was 3 seconds.

It was decided to drive this machine by a 30 B. H. P. motor at 500 revolutions per minute, compounded so as to give a maximum variation of about 12 or 14 per cent. Allowing a 40 per cent momentary overload on the motor would bring the maximum horse-power allowable on reversal to 42, and the additional 13 horse-power would have to be supplied by the fly-wheel. The dimensions of the wheel were obtained in the following manner:

As energy in a moving body varies directly as V^2, where V = velocity in feet per second, it is clear that the best place for the fly-wheel is upon the shaft having the greatest number of revolutions per minute, which, of course, is the motor shaft.

From the figures given, it will be seen that the wheel must be capable of parting with sufficient energy to develop 13 horse-power during the time of reversal, *viz.*, 3 seconds, and its drop in speed must not exceed 10 per cent, so as to keep the actual variation slightly below that allowed by the motor.

$$\text{Energy to be given out by the fly-wheel} = \frac{13 \times 33{,}000 \times 3}{60}.$$

Now assume M to be the store of energy in foot-pounds in this fly-wheel when it makes one revolution per minute, then, as the energy varies as V^2, and V varies as the revolutions per minute, the store of energy in the wheel when making 500 revolutions per minute $= M \times 500^2$.

As the drop of speed of the wheel = 10 per cent speed of wheel at end of 3 seconds then the speed of the wheel = 500 — 10 per cent of 500 = 450 revolutions per minute, and the store of energy then in the wheel $= M \times 450^2$.

Thus the energy given up by the wheel in being reduced from 500 to 450 revolutions per minute $= M\ (500^2 - 450^2)$.

But the energy given up must $= \frac{13 \times 33{,}000 \times 3}{60}$, as already shown; therefore $M\ (500^2 - 450^2) = \frac{13 \times 33{,}000 \times 3}{60}$.

$$M = \frac{13 \times 33{,}000 \times 3}{60\ (500^2 - 450^2)}.$$

$$= \frac{13 \times 33{,}000 \times 3}{.60 \times 47{,}500}$$

$M = 0.45$ foot-pounds.

Therefore, the store of energy in the fly-wheel when making 1 revolution per minute = 0.45 foot-pounds.

The limit of peripheral speed of plate fly-wheels generally allowed in machine tool practice is about 7,000 feet per minute, which quantity will enable us to find the outside diameter of the wheel thus: $\frac{7{,}000}{3.1416 \times 500} = 4.4$ feet.

As energy in a revolving wheel $= \frac{W V^2}{2g}$, where V = velocity in feet per second at center of area of rim, $\frac{W V^2}{2g}$ must equal 0.45 when the wheel makes 1 revolution per minute. Therefore $\frac{W V^2}{2 \times 32.2} = 0.45$.

Velocity of wheel in feet per second when wheel makes 1 revolution per minute $= \frac{4 \times 3.1416}{60}$; the diameter of the wheel to center of area, it will be seen, is taken as 4 feet, 4.4 feet being the outside diameter, thus

$$\frac{W \times 4 \times 4 \times 3.1416 \times 3.1416}{2 \times 32.2 \times 60 \times 60} = 0.45.$$

$$W = \frac{0.44 \times 32.2 \times 2 \times 60 \times 60}{4 \times 4 \times 3.1416 \times 3.1416},\ W = 660 \text{ pounds.}$$

Thus, knowing the outside diameter and the weight of the wheel, the other dimensions are very easily ascertained.

* * *

The municipal authorities of Paris, France, on account of the manner in which some lately erected high buildings, imitation skyscrapers, are marring the beauty of that city, are considering to re-enact the lately annulled laws restricting the height of buildings. Such restrictions are very important, not only on account of the appearance of the city, but because of many other problems created by the high buildings. Had it not been for the skyscrapers on the lower part of Manhattan Island in New York, the present traffic problems in that city would not have presented such enormous difficulties. The necessity for hundreds of thousands of people to be transported every morning and night to and from a little plot of land but a few acres in extent is caused by nothing else than the existence of the high buildings, which permit so great a number of people to work on so small an area.

---

*For previous articles on this and kindred subjects see MACHINERY, June, 1895, Designing and Constructing Modern Steam Engines; May, 1900, Gas Engine Design; July, 1904, Planer with Quick Return of 200 Feet per Minute; June, 1905, High-Speed Planers; July, 1905, An English High-Speed Planer; July, 1907, Size, Weight and Capacity of Fly-Wheels for Punches.

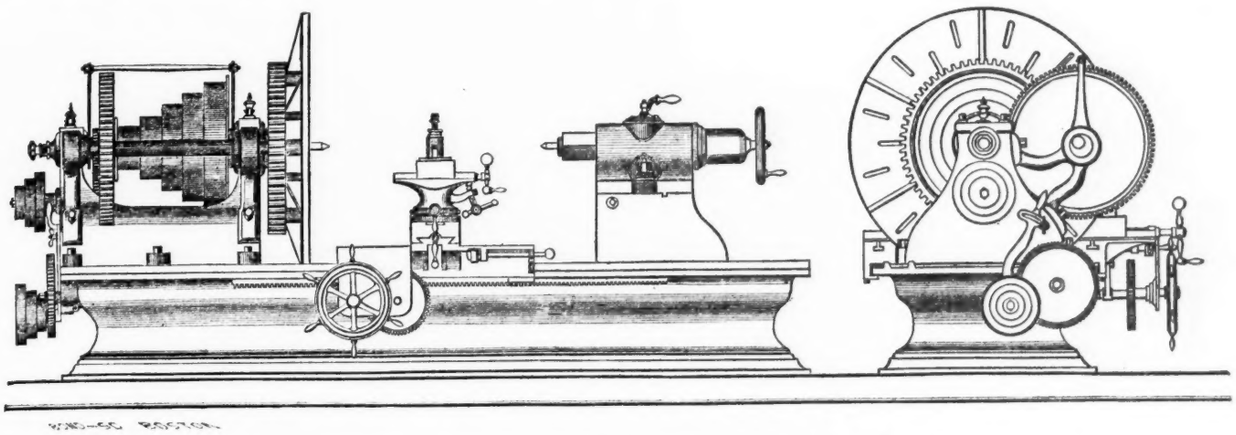
†Address: 28 Church Ave., Weaste, Manchester, Eng.

‡W. Owen was born in Blackburn, Eng., in 1881. He served an apprenticeship with Hulse & Co., Manchester, machine tool builders, and in conjunction with his apprenticeship attended engineering courses at the Royal Technical Institute, Salford. Upon leaving Hulse & Co. he went with Craven Bros., also of Manchester, where he is now employed. Mr. Owen is also on the engineering staff of the Royal Technical Institute, Salford. His specialty is machine tool design.

SOME OLD MACHINERY CATALOGUES.

A few weeks ago the editor had the opportunity of examining a number of old machine tool catalogues collected by Mr. Henry E. Eberhardt, president of the Eberhardt Bros. Machine Co., Newark, N. J. The catalogues are interesting from both a mechanical and commercial standpoint. Some day, if not at present, the catalogues of machinery builders issued in the '60's and '70's will be highly regarded by the historian of manufacturing.

The oldest catalogue in the collection is that of the Lowell Machine Shop, Lowell, Mass. It is dated January, 1863, and is of the fourth edition. J. Thomas Stevenson was treasurer, and Andrew M. Moody superintendent. The first edition of the list of tools made by the Lowell Machine Shop was printed in 1851. The company manufactured all kinds of cotton machinery, locomotives, turbine water mills, mill gearing and shafting, but the catalogue before us is devoted to machine tools, including engine lathes, hand lathes, vertical drilling machines, horizontal drilling lathes, boring and reaming lathes, planing machines, shapers, crank-pin boring lathes, bolt cutting machines, gear cutting and dividing machines, slotters, tilt and trip hammers and punch presses. The illustrations are lithographic reproductions of line drawings, each illustration being an insert, blank on the back side. The prices throughout are filled in with ink. The character of the illustrations is indicated by the accompanying reproduction of a "No. 6 engine lathe." This machine had a bed 16 feet long, and would turn a piece 9½ feet long. It weighed 11,000 pounds, and sold for $2,310. It was also made in 18-, 24-, and 32-foot beds. The spindle was made of cast iron, and the lathe would turn 50 inches diameter over the slide and 32 inches over the tool rest. It will be noted that the lathe was back-geared into a gear on the face-plate. This was the largest and heaviest machine built by the company.



Sample Illustration in Catalogue of the Lowell Machine Shop, showing No. 6 Engine Lathe.

Other firms whose catalogues are included in the collection are: William Sellers & Co., Philadelphia, Pa., 1870; Lucius W. Pond, Worcester, Mass., 1874; Brown & Sharpe Mfg. Co., Providence, R. I., 1875; F. E. Reed, Worcester, Mass., no date; Niles Tool Works, Hamilton, Ohio, 1880; Brainard Milling Machine Co., Hyde Park, Mass., 1880; E. E. Garvin & Co., New York, 1883; Putnam Machine Co., Fitchburg, Mass., 1884. Of course the catalogues issued in the early '80's belong to comparatively recent history, but, nevertheless, one notes a great change in the power, massiveness, and general design of machine tools within the last twenty-five years. If space had permitted, several additional views could have been reproduced, showing some of the marked changes in the product of these machine tool builders.

A comparison made between these catalogues and the present issues of the same concerns is instructive, especially in the case of so widely distributed an example as the catalogue of the Brown & Sharpe Mfg. Co. This company's issue of January 1, 1875, is a 3 x 5¼-inch booklet of 74 pages, including the cover, printed on thin paper; the catalogue for 1907 contains 500 pages, 3½ x 5¾ inches, and it would be much larger if the matter was not condensed so as to include only the essentials.

THE MACHINE SHOP DON'TS AS A SPIRITUAL FORCE.

Nothing ever published in MACHINERY has attracted more attention from practical machinists and others connected with machine shops than the "don'ts" for machinists and draftsmen, which appeared by installments in June and October, 1905, and February and October, 1906, issues. They were contributed by Mr. H. E. Wood, formerly of Pearl River, N. Y., now of Hartford, Conn., and represented, in concentrated form, some of the wisdom acquired by years of varied experience as a machinist and foreman. So popular were these tabloids of shop common sense that they were reprinted in pamphlet form for general distribution, and over 200,000 copies have been put in the hands of mechanics in the United States, Canada, Great Britain, and other English-speaking countries. Now, what we started to say was that while, in common with mechanics generally, we had a keen appreciation of the epigrammatic vigor and general hard sense of these shop don'ts, we had not looked upon them as a particular force for good in the spiritual world, but it appears that they have been so regarded. The following letter from the editor of *The Sunday School Times*, Philadelphia, refers to them in a very appreciative manner:

Recently *The Sunday School Times* published a couple of editorial notes on its first page based on the strikingly suggestive and helpful points in the little booklet that you published, entitled "Don'ts for Machinists and Draftsmen." Rarely have we had anything attract quite so much attention among these front-page editorial paragraphs. I thought you would be interested to know this, and I enclose clippings of the two paragraphs referred to. So you see you are reaching folks in the realm of spiritual character as well as in the realm of mechanical efficiency. C. G. TURNBULL,

October 30, 1907. Editor.

Following is one of the notes referred to:

There are not two different sets of principles for material and spiritual success. Whatever really helps in one field will help in the other,—only the sons of this world are often wiser than the sons of light. A series of "Practical Don'ts for Machinists," issued by a prominent trade publication, contains a good many hints that all of us in life's big machine shop would do well to heed,—though the series is labeled "For the other fellow—not you." Here are some of them: "Don't say 'that's good enough.' Don't borrow tools; buy your own. Don't let your lathe run and cut air. Don't be always looking for pay-day. Don't be too important to do insignificant jobs. Don't take off your overalls before quitting time. Don't try to fool your foreman, for you may get left. Don't wait until Monday morning to fill your oil-can. Don't deny spoiling a piece of work if you have done it. Don't work to a caliper that has been set by another man; set it yourself." The man or woman whose life is controlled by such principles as these is bound to have the respect of fellow-workmen, and the quality of the work done is likely to mean promotion by the Foreman.

* * *

A recent inquiry into some of New York City's municipal accounts discovered that in one instance 165 coat hooks had been sold to the city at 60 cents apiece, which could be bought at retail for about 5 cents apiece; but the worst is not yet. These hooks were put up by a plumber and a helper, who charged at the rate of $8.00 per day for their time. They consumed 31 days doing the job!

REAMERS.—5.

ERIK OBERG.*

Pipe Reamers.

Pipe reamers, Fig. 21, are used to precede pipe taps. They are made of the same sizes as pipe taps, excepting that the dimensions of the pipe reamer correspond to the root diameters of the thread of pipe taps. The taper of pipe reamers is ¾-inch per foot. They are fluted with the same kind of cutters as hand reamers of sizes corresponding to the diameters at the small end of the pipe reamers. Finishing reamers only are used. The number of flutes for different pipe sizes is as follows:

Pipe Size.	Number of Flutes in Reamer.
From ⅛ to ¾	6
From ½ to ¾	8
From 1 to 1¼	10
From 1½ to 2	12
From 2½ to 3	14
3½	16
4	18

The small end of pipe reamers is slightly chamfered, as shown in Fig. 21, in order to facilitate the entering of the reamer in holes which are of about the same size as the small diameter of the reamer. Dimensions for pipe reamers are given in Table XIX.

Pipe reamers are tested or measured by means of taper ring gages to insure that they are within the permitted limits of variation. The diameter at the small end of the hole in these ring gages equals the diameter at the small end of the reamer. Thus, when the reamer is tested with the ring gage, if the end of the reamer comes exactly flush with the end of the gage, the size of the reamer is exactly

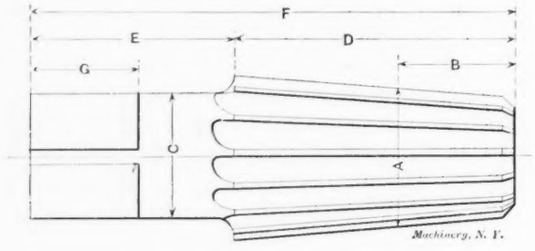


Fig. 21. Pipe Reamer.

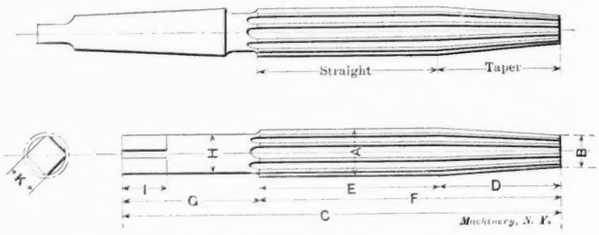
TABLE XIX. DIMENSIONS OF PIPE REAMERS.

Pipe Size.	Diameter at Size Line.	Distance from Size Line to Small End.	Diameter of Shank.	Length of Fluted Part.	Length of Shank.	Total Length.	Length of Square.	Size of Square.
	A	B	C	D	E	F	G	
⅛	0.343	25/64	11/32	1	1⅝	2⅝	½	¼
¼	0.447	9/16	7/16	1⅛	1¼	2⅜	9/16	5/16
⅜	0.582	9/16	9/16	1¼	1⅞	3⅛	⅝	7/16
½	0.721	¾	½	1½	2	3½	11/16	9/16
¾	0.931	¾	15/16	1⅝	2¼	3⅞	¾	11/16
1	1.170	15/16	1 1/16	1⅝	2½	4¼	13/16	13/16
1¼	1.515	31/32	1 5/16	1½	2¾	4⅝	1	¾
1½	1.755	1	1 5/8	2	3	5	1 1/8	1 1/8
2	2.230	1	1 7/8	2¼	3½	5⅝	1 ⅜	1 ⅜
2½	2.667	1 1/8	2 1/4	2⅞	4	6⅞	1 11/16	1 11/16
3	3.292	1 9/16	2 ⅝	3¼	4½	7¾	1 15/16	1 15/16
3½	3.792	1 ⅝	2 13/16	3⅝	4 9/16	8 3/16	2 1/8	2 1/8
4	4.292	1 11/16	3	3¾	4⅝	8⅝	2 ¼	2 ¼

correct. If the end of the reamer projects through the gage, it indicates that the reamer is too small, and if it comes short of the face at the end of the gage, the reamer is too large. It is considered a permissible error if the end of the reamer projects through, or falls short of, the ring gage 1/32 inch for sizes up to and including 1 inch pipe size, 1/16 inch for 1¼ to 3 inch pipe size, and ⅛ inch for larger sizes.

Taper Reamers for Bridge Builders.

Taper reamers for bridge builders, commonly called bridge reamers, are made with Morse taper shank or straight squared shank, as shown in Figs. 22 and 23. The fluted portion is tapered for distance *D*, and is straight for the remaining part *E*, of the flutes. These reamers are used for rough structural construction work, and are not required to be finished with the same degree of care as reamers for machine construction. After hardening, the flutes are usually left unpolished. These reamers are made in sizes from ½ to 1¼ inch. The taper per foot of the tapered portion at the end of the reamer, as usually made, is given in Table XX together with the essential dimensions of the straight shank



Figs. 22 and 23. Taper Reamers for Bridge Builders.

TABLE XX. DIMENSIONS OF REAMERS FOR BRIDGE BUILDERS.

Diameter of Straight Part of Reamer.	Diameter at Point of Reamer.	Taper per foot of Tapered Portion.	Total Length of Reamer	Length of Tapered Part.	Total Length of Flute.	Length of Shank.	Diameter of Shank.	Length of Square.	Size of Square.
A	B		C	D	F	G	H	I	K
½	¼	1	8⅛	3	5¼	2¼	7/16	½	5/16
9/16	5/16	1	8⅛	3	5¼	2¼	½	9/16	5/16
⅝	11/32	1⅛	8⅛	3	5⅛	2¼	9/16	⅝	7/16
11/16	⅜	1¼	8⅞	3	6	2⅝	⅝	11/16	7/16
¾	7/16	1¼	9⅛	3	6¼	2⅝	11/16	¾	½
13/16	½	1¼	9⅛	3	6⅛	2⅝	¾	13/16	9/16
⅞	9/16	1¼	9⅛	3	6⅛	2⅝	13/16	⅞	5/8
15/16	⅝	1¼	9⅞	3	6 15/16	2 15/16	⅞	15/16	11/16
1	11/16	1¼	10⅛	3	7⅛	3	⅞	1	11/16
1 1/16	23/32	1⅛	10¼	3	7¼	3	15/16	1 1/16	11/16
1 ⅛	¾	1½	10⅜	3	7⅜	3	1	1 ⅛	¾
1 3/16	13/16	1½	10½	3	7½	3	1 1/16	1 3/16	13/16
1 ¼	⅞	1½	10⅝	3	7⅝	3	1 ⅛	1 ¼	⅞

type reamer. The dimensions for the fluted portion of those with Morse taper shank are exactly the same, the only difference being the total length, which, of course, is dependent upon the size of Morse taper shank used. The common practice is to provide the ½ up to ⅞ inch sizes with No. 2, and all sizes 11/16 inch and larger in diameter with No. 3 Morse taper shank. The size of the reamer is measured on the straight part of the flutes. In the case when an odd number of flutes is employed, the size must be determined by a ring gage. The number of flutes is made 5 in all sizes below and including ⅞ inch diameter, and 6 for larger sizes.

Grooved Chucking Reamers.

The tool shown in Fig. 24 is partly a reamer and partly a twist drill. The cutting is performed by the beveled edges *A*, which form an angle of 60 degrees with the axis of the tool. The reamer is provided with three larger semicircular flutes, which are cut on a right-hand spiral, and with

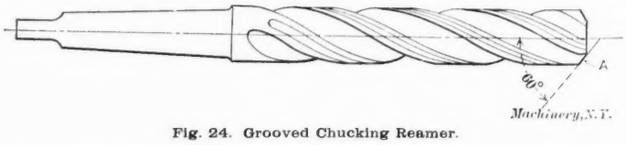


Fig. 24. Grooved Chucking Reamer.

three smaller grooves between these. The larger grooves form passages through which the chips pass away; the smaller grooves convey the lubricant to the cutting edges. This form of reamer is extensively used in screw machines for enlarging cored holes, and also in drill presses for enlarging drilled holes, it being easier to enlarge a drilled hole to size by a grooved chucking reamer than to try to drill the hole to size by an ordinary twist drill.

This reamer is commonly provided both with straight and Morse taper shank. When provided with Morse taper shank,

* Associate Editor of MACHINERY.

the following numbers of taper shanks should be used for the various sizes of grooved reamers:

Diameter of Reamer.	No. of Morse Taper Shank.
From ¼ to ½ inch	1
From 9/16 to ⅞ inch	2
From 15/16 to 1¼ inch	3
From 1 5/16 to 1¾ inch	4
From 1 13/16 to 3 inches	5

The length of the fluted part being given in Table XXI, the total length of the reamer is dependent upon the length of the Morse taper shank used. When made with straight

TABLE XXI. LENGTH OF FLUTED PORTION OF GROOVED CHUCKING REAMERS.

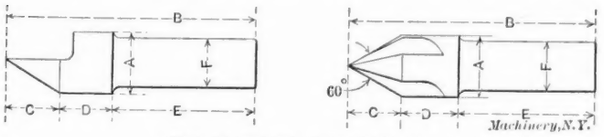
Diameter of Reamer.	Length of Fluted Portion.	Diameter of Reamer.	Length of Fluted Portion.	Diameter of Reamer.	Length of Fluted Portion.
¼	4	⅞	8¼	2	9¾
5/16	4½	15/16	8⅜	2⅛	9⅞
⅜	5	1	8½	2¼	10
7/16	5½	1⅛	8¾	2⅜	10⅛
½	6	1¼	9	2½	10¼
9/16	6½	1⅜	9⅛	2⅝	10⅜
⅝	7	1½	9¼	2¾	10½
11/16	7½	1⅝	9⅜	2⅞	10⅝
¾	8	1¾	9½	3	10¾
13/16	8½	1⅞	9⅝	..	...

shank, this latter may be selected of such length that the total length of the tool is the same as when a Morse taper shank is used.

The diameter at the point of this reamer is larger than at the shank end of the flutes, the amount of back taper being 0.003 inch per foot. This prevents the tool from binding in the holes chucked. The spiral of the flutes should be so selected that the edges of the flutes make an angle of between 25 and 20 degrees with a plane through the axis of the reamer. This corresponds to a lead of the spiral equal to from about 7 to 8.5 times the diameter of the reamer, respectively. This is practically the same amount of spiral as is used on twist drills.

Center Reamers.

Center reamers are used for forming the centers on which work is to revolve in lathes or grinding machines. They are made in two different styles. The older one, Fig. 25, has



Figs. 25 and 26. Center Reamers.

TABLE XXII. DIMENSIONS OF CENTER REAMERS.

Full Diameter of Reamer.	Total Length.	Length of Beveled Portion, Approx.	Length of Straight Portion.	Length of Shank.	Diameter of Shank.
A	B	C	D	E	F
¼	1⅜	7/32	5/32	1	3/16
⅜	1½	5/16	5/16	1	¼
½	2	7/16	7/16	1⅛	5/16
⅝	2⅝	17/32	17/32	1¼	7/16
¾	2⅝	21/32	23/32	1¼	½
⅞	2¾	¾	¾	1⅜	9/16
1	3⅛	⅞	1	1½	⅝

only one cutting edge, formed by cutting away the metal down to the center of the tool, and relieving the beveled portion of the remaining half so that a cutting edge is produced. The second and later style is that shown in Fig. 26, which has four flutes or cuts. These cuts are straight, and the lands between the cuts are relieved on the beveled part. The inclusive angle of the point of the tool must, of course, be that used for lathe centers, or 60 degrees. These reamers are made with a straight shank. The dimensions of both styles are the same, and are given in Table XXII.

Flat-sided Reamers.

Very small reamers are sometimes provided with flats instead of actual flutes, the sharp intersection or corner between two flats acting as a cutting edge. These reamers are used for small dowel and taper pin holes, etc. The diameter of the reamer is, of course, measured over the sharp corners. If the reamer tapers, the taper of the flats will evidently not be the same as the taper of the reamer itself, and the milling machine head used when milling the flats must be set to a different angle than that which the cutting edge makes with the center line. A simple formula, expressing the relation between the taper per foot, the number of flat sides in the reamer, and the angle to which to set the milling machine head, was given in the "How and Why" section of MACHINERY, January, 1907. This formula reads:

$$\text{Tangent angular setting} = \frac{\text{½ taper per foot}}{12} \times \text{cosine} \frac{360 \text{ degrees}}{2 \times \text{number of sides in reamer.}}$$

Adjustable Reamers.

In order to permit the diameter of the hole reamed to be slightly varied from the standard size, adjustable reamers are used. These may be of two classes, such as are adjustable but still have the cutting edges composing an integral part of the reamer, as shown in Fig. 27, and those which have inserted blades. The former are usually employed in smaller sizes only, while the latter are commonly used in sizes from 1¼ inch up to 5 inches diameter. On account of the construction of the class of reamers shown in Fig. 27, the reamer cannot expand uniformly its entire length; when that is desired, the reamer with inserted blades must be selected.

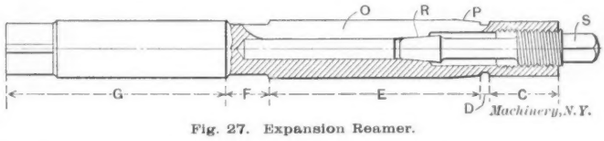


Fig. 27. Expansion Reamer.

Adjustable reamers are often called expansion reamers, and there is no real difference between the two kinds. If any distinction should be made, it would be advisable to call reamers of the type shown in Fig. 27 expansion reamers, as the change in diameter is actually effected by expanding the tool itself, while inserted blade reamers should be called adjustable reamers.

Referring to Fig. 27, the reamer shown is originally an ordinary hand reamer provided with a guide. The distance *C* represents this guide; *D*, a small neck or groove between the guide and the reamer body; *E*, the cutting edges; *F*, the neck between the cutting edges and the shank, and finally *G*, the shank. At the forward end of the cutting edges there is a small taper at *P*, the same as in ordinary hand reamers, and the diameter of the guide, which is not fluted, is in the same proportion to the full diameter of the reamer as for hand reamers.

The body of the reamer is hollow, and three slits are cut with 1/32-inch saw from the outside to the hole in the center. One of these slits is shown in the cut at *O*. The inside hole is tapered at *R*, and a tapered plug *S*, provided with a threaded part, serves as expander. The thread engages a threaded portion in the reamer guide, and, when the expander is turned so that the plug moves inward, on account of the taper at *R*, the cutting edges of the reamer are forced outward, a slight spring action being possible because of the slits being cut through the reamer body. The slits should extend into the neck, and end at the upper end of the guide, as shown. They should be cut in the bottom of a flute, so as not to impair the cutting edges.

Reamers of this type cannot be recommended for accurate work. It is evident that the expansion takes place opposite the tapered part *R*, and that the cutting edge is sprung up in an arc. The reamer will have no parallel cutting edges, and, unless the guide fits the original hole closely, will hardly be able to ream straight. For cheaper grades of work, however, the feature of a simple means of expansion may be deemed valuable.

Reamers of the inserted blade type were discussed in the July issue of MACHINERY, and it does not seem necessary to repeat the statements there made. In order to give an idea, however, of the dimensions which should be followed in

laying out any type of inserted blade reamer, Tables XXIII and XXIV are appended. The dimensions given in these tables are, of course, not intended to be followed too strictly, as varying designs may require modifications. The dimensions will, however, serve as a guide in laying out adjustable reamers, when required to be designed for special conditions, and will give an idea of the general proportions. They refer, of course, more particularly to reamers of a design similar to that shown in the article in the July issue, referred to above.

Inserted blade shell reamers should be ground with a back taper of 0.012 inch per foot. The shank of inserted blade hand reamers should be ground 0.002 inch smaller in diameter than the minimum size for which the reamer is intended.

TABLE XXIII. ADJUSTABLE HAND REAMERS.

Diameter of Reamer.	Length of Cutting Edge.	Thickness of Blade.	No. of Blades.	Total Length of Reamer.	Diameter of Reamer.	Length of Cutting Edge.	Thickness of Blade.	No. of Blades.	Total Length of Reamer.
1¼	2⅜	3/16	6	9	2½	4	¼	6	12½
1⅜	2⅝	3/16	6	9⅜	2¾	4¼	¼	6	13
1½	3	3/16	6	9½	3	4½	¼	8	13½
1⅝	3¼	7/32	6	10¼	3¼	4⅝	5/16	8	14
1¾	3¼	7/32	6	10½	3½	4¾	5/16	8	14½
1⅞	3⅜	7/32	6	10⅞	3¾	4⅞	5/16	8	15
2	3½	7/32	6	11¼	4	5	5/16	8	15½
2¼	3¾	¼	6	12	..	..	..	..	...

TABLE XXIV. ADJUSTABLE SHELL REAMERS.

Diameter of Reamer.	Length of Cutting Edge.	Thickness of Blade.	No. of Blades.	Diameter of Reamer.	Length of Cutting Edge.	Thickness of Blade.	No. of Blades.
1¼	1⅜	3/16	6	3	3¼	¼	8
1⅜	1⅝	3/16	6	3¼	3½	5/16	8
1½	1⅞	3/16	6	3½	3¾	5/16	8
1⅝	2	7/32	6	3¾	4	5/16	8
1¾	2¼	7/32	6	4	4¼	5/16	8
1⅞	2⅜	7/32	6	4¼	4½	5/16	10
2	2⅝	7/32	6	4½	4⅝	5/16	10
2¼	2½	¼	6	4⅝	4⅞	⅜	10
2½	2¾	¼	6	5	5	⅜	10
2¾	3	¼	6	..	..	..	..

The present article is the concluding one in the series of five articles on reamers which have been presented. It has been the purpose of the author to give such information as would be the most useful to the practical tool-maker. For this reason, the processes of manufacture, which the practical tool-maker is presupposed to be familiar with, have not been dealt with except in cases where reference to these processes seemed necessary to explain certain points, but the actual figures for dimensions, number of flutes, etc., have been the more carefully stated in every case, as there has never hitherto been published any systematized information on these subjects.

* * *

Not the least of the many notable applications of electricity in the arts which have effected substantial economies, is electric soldering. The gas-heated soldering iron was a decided improvement over the ordinary bit heated in a charcoal furnace, but it has faults very noticeable when compared to the electrically-heated iron. The flexible tubing, auxiliary air supply, waste heat and danger of poisoning by the escape of gas are all absent with the electric equipment. But aside from the convenience and flexibility of the system, the increased efficiency is in itself a deciding factor. A manufacturer of tin lanterns counted on five per cent of the day's output being "leakers" when using gas-heated soldering irons; with electric irons the percentage has dropped to one-half per cent, and the most of these defects are due to checks, cracks, and similar defects in the stock, largely caused by the forming dies. The practical result is that each man's daily output is increased nearly five per cent, with no added exertion; in fact, the conditions of working are easier than before.

THERMIT REPAIR OF STEAMSHIP STERN FRAME AND RUDDER POST.*

A remarkable repair was recently effected on the steamship *Corunna*, of the Canadian Lake Navigation Company, at Montreal. This vessel is of 1,296 tons register, 240 feet long, 35 feet beam and 21 feet in depth. In getting away from her pier in the Lachine Canal, the stern of the vessel was caught by the current and swung against the stone walls of the canal, the shoe or skeg being broken off close to the heel, while the rudder post was broken at a point about eighteen inches from the top of the rudder. Owing to the serious nature of the injuries, it would have been necessary to tow the vessel to Cleveland, there being no adequate dry-dock in Montreal to make these repairs in the usual way, were it not for the fact that by the thermit process it is possible to effect such repairs without removing the stern frame from the ship or requiring the aid of machinery of any kind other than a compressed air blow torch and a few pneumatic tools. It was

Fig. 1. Rudder of Steamship "Corunna," showing new Stem Welded with Thermit.

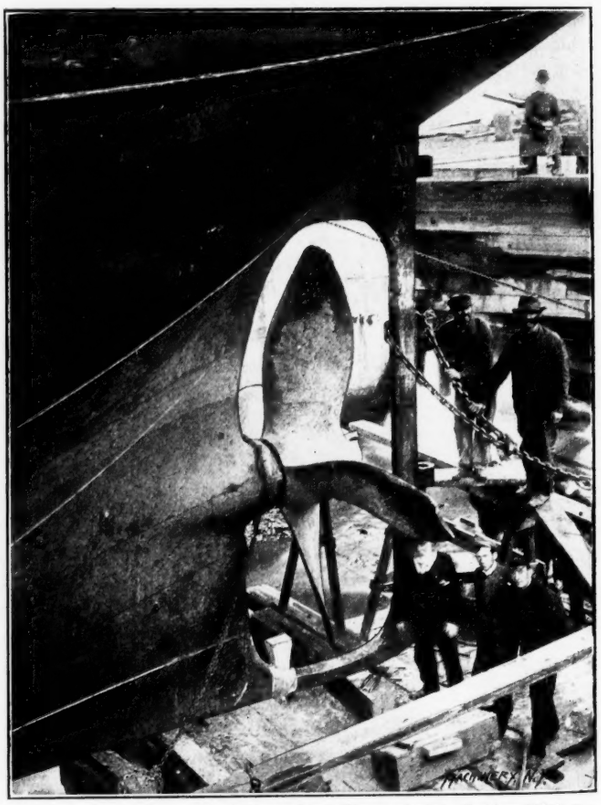


Fig. 2. Showing Thermit in Shoe of Stern Frame, before Cutting Off Gate.

* For other articles on thermit and thermit repairs see MACHINERY, March, 1901, "Some Future Possibilities of Aluminum," by C. Vickers; March, 1903, "The Thermit Process," by Frank C. Perkins, "The Use of Thermit for Repairing," and "Thermit and Its Possibilities"; December, 1903, "Lecture upon Thermit."

therefore decided that several thousand dollars could be saved by repairing the frame and rudder post with thermit, and the Goldschmidt Thermit Co., 90 West street, New York, was advised by telegraph to send an engineer to direct the operation.

On inspection it was found that the rudder post was broken off inside the tube, while the stern frame had been bent 12 inches out of line, the shoe being completely broken about 13 inches from the center line of the post. On account of the break in the rudder post being in an old scarf weld, fully 11 inches in length, it was not deemed advisable to attempt to

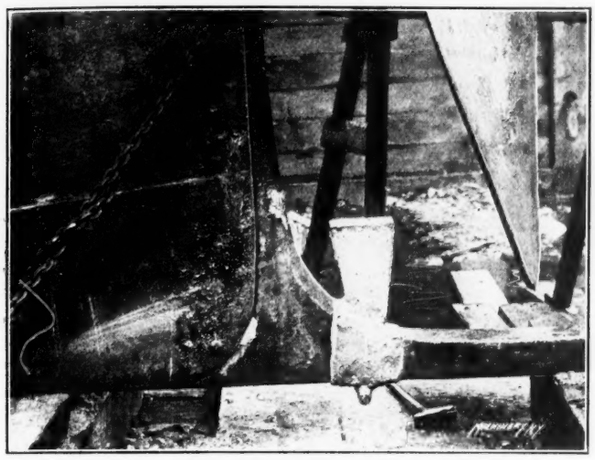


Fig. 3. Near View of Stern Frame Shoe Repair, showing Large Size Thermit Weld and Gate.

weld this again, so about 14 inches of the rudder post adhering to the rudder was cut off and a new piece of shafting, 8 feet long, was welded on in place of the old post, as shown in Fig. 1. In order to facilitate operations, the rudder was removed from the ship and the post welded on shore, this being done to prevent interference with the operation of welding the stern frame.

It was necessary to have a supply of compressed air in order to operate a gasoline torch and some pneumatic tools, so an old Westinghouse steam driven air brake compressor

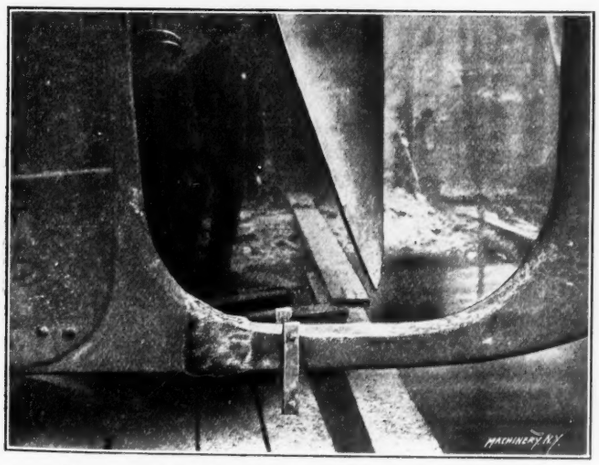


Fig. 4. Showing Stern Frame Shoe after Gate was Cut Off.

was obtained and mounted on board ship, steam being piped from a donkey boiler. A receiving tank was placed on the edge of the dock and piped to the compressor.

With the apparatus in place, preparations were made to do the welding, the rudder being the first repair to be made. This was unshipped and welded in exactly two working days, the operation being in all respects similar, though on a smaller scale, to the method pursued in welding the stern frame. It is sufficient to say that the section which had to be welded was circular, 5¼ inches diameter, and was reinforced at the weld by a collar of thermit steel 8 inches long and 1 inch thick. For this operation 150 pounds of thermit, 25 pounds of steel punchings, and 3 pounds of metallic manganese were used. The results were extremely satisfactory, and when the riser and gate were cut off, the metal was seen to be of very fine grain.

The next operation was to straighten the stern frame, after which a series of holes were drilled along the line of the fracture, to provide for a free flow of thermit steel. As soon as this had been done, a collar of yellow wax was shaped around the fracture, the frame section being approximately 5 x 13 inches at the forward edge of the collar and 6 x 7 inches at the rear portion, while the section at the break was about 6½ x 7 inches. This collar was made 8 inches long with a middle ordinate of 1 inch; a sectional view would show approximately the segment of a circle. On the bottom, however, it was made only ¾ inch thick, in order that the draft of the vessel might not be made any greater than could be helped.

With the wax in position, a sheet iron mold box was placed around it, allowing for 6 inches of sand on all sides. Wooden patterns were constructed for a narrow gate and large riser, and provision was also made for leaving a small hole near the bottom of the mold, for the wax to run out when heated. After the mold was completed the flame of a strong gasoline blow torch was directed into this hole, and the heating continued until all the wax was out of the mold and the parts to be welded had been brought to a bright red heat. In the meantime a crucible containing 350 pounds of thermit, 70 pounds of steel rivets (1 inch x ⅜ inch in size), and 7 pounds of metallic manganese, was placed in position over the pouring gate.

It required about three hours to bring the sections to the proper heat, at which time the torch was removed, the hole at the bottom plugged up with a sand core, backed up with a few shovelfuls of sand, the thermit ignited in the crucible and the resulting superheated steel tapped into the mold, where it filled the space formerly occupied by the wax. The mold box was not removed for about 15 hours, in order that the thermit steel might become thoroughly annealed, but it was found, upon taking away the mold, that the weld was perfect in every respect, being inspected and passed on by Lloyd's surveyors, Capt. Reid and Mr. Calderwood. Figs. 2 and 3 show the thermit weld and large riser, which latter is characteristic of successful thermit repairs the same as of good steel castings. Fig. 4 shows the stern frame shoe after the riser was cut off.

The total time required for the two welds amounted to five working days, but there is no doubt that had the work been done in a properly equipped dry-dock, it could probably have been completed in three days or less.

* * *

We stated in a note in our December, 1906, issue that manufacturers of taps and cutting tools which cannot be ground after hardening did not consider it good policy to make these out of high-speed steel, on account of the high heat necessary when hardening, which caused the edges to fuse. We understand, however, that at the present time several firms are able to harden high-speed steel taps, hobs and similar tools in such a manner that the cutting edges are not impaired, and Wheelock, Lovejoy & Co., Boston, Mass., it is stated, have demonstrated that such hardening can be successfully accomplished by using a barium chloride bath in a standard gas-burning furnace. The investigations have been carried out in connection with blue chip high-speed steel, but equally satisfactory results may be secured with other high-speed steels. The application of barium chloride for hardening purposes was first developed abroad. Barium chloride in crystal form is placed in a crucible in the furnace, and melts into a bluish, milky fluid. When used as a hardening bath, the temperature varies from 2,000 to 2,300 degrees F., and very uniform results are claimed to be obtainable by this process; but the exact time during which each particular tool will have to be subjected to the treatment in the hardening bath will have to be established by experiments. It may be mentioned, however, for the guidance of those who are to use this process for hardening, that, according to the *Iron Age*, a ⅝-inch tap is subjected to a temperature of 2,100 degrees F. for four minutes when hardening by the process mentioned.

Copyright, 1907, by THE INDUSTRIAL PRESS.

Entered at the Post-Office in New York City as Second-Class Mail Matter.

MACHINERY

REGISTERED IN UNITED STATES PATENT OFFICE.

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

49-55 LAFAYETTE STREET, CORNER OF LEONARD,

NEW YORK CITY.

Alexander Luchars, President and Treasurer.

Matthew J. O'Neill, Secretary.

Fred E. Rogers, Editor.

Ralph E. Flanders, Erik Oberg, Franklin D. Jones, Associate Editors.

The receipt of a subscription is acknowledged by sending the current issue. Checks and money orders should be made to THE INDUSTRIAL PRESS. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Single copies can be obtained through any newsdealer.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

DECEMBER, 1907.

PAID CIRCULATION FOR NOVEMBER, 1907, 24,096 COPIES.

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

TO MAKE MACHINERY OF PERMANENT VALUE.

Some of our readers seem to be under the impression that the frequent references to previous articles on machine design, etc., lately appearing in the form of foot-notes, were made to advertise back issues for sale. This is a mistake. We have scarcely any copies for sale, and, not infrequently, it has occurred that an issue was entirely exhausted before the next month's issue was published. The cost of clerical labor, storage, etc., makes it unprofitable for publishers of trade papers to print more copies than are required to meet the immediate demand. No; the reason for making references to what has gone before is simply to make MACHINERY of greater permanent value to those who keep its files. We feel that the reader who does not keep a file loses a large part of the value of his subscription. The subject which has no importance to you to-day may be what yields your bread and butter next year, and any literature on it will be very valuable. The text-books are indispensable, but they cannot cover everything, nor can they keep up to date. The side lights thrown on certain features of design by the published experience of contributors are most valuable, often being of a nature that the text-books ignore. There, too, is the matter of historical record of machine tool growth. The columns of MACHINERY present a most complete record of its development—a record that no one interested can afford to lose.

To those who feel that they cannot afford the cost of a permanent binding by a book-binder, we would suggest the use of a Shipman binder, 9 x 13 inches, price, about 80 cents. This binder will hold two years' issues. Place the indexes in front of each volume, and separate the two volumes with a sheet of heavy colored paper. In this way a large amount of valuable material will be put in shape for instant reference, and at a very low cost.

* * *

RESULT OF MECHANICAL FILE TESTING.

Something more than two years ago a British machine was developed for mechanically testing files and autographically recording the result. The autographic record shows the cubic inches removed by a file from a standard test bar, the number of strokes taken, the period when the file cuts most effectively, and when it ceases to cut because of being worn out. The publication of comparative results obtained from tests made on files purchased in the open market created a sensation among file makers and file users. The difference between the best files and the poorest files was so great that a manufacturer clearly could not afford to use the poorest files, even if supplied free of cost. This result, of course, merely confirmed what every intelligent shop manager already knew, but the mechanical record of the actual difference in cubic inches removed and strokes made was a more definite proof.

The valuable result of the file testing machine's work is the great improvement that has taken place since the file maker was given the means of accurately testing his product. At the advent of the file testing machine, the best files were able to remove about 12½ cubic inches, and the best files were about twelve times as effective as the poorest. In 1907, two years after, the file makers had so improved their product that the best file tested removed at the rate of eight cubic inches per 10,000 strokes, and 55 cubic inches of cast iron with *one side* of the file, or about 4 2/5 times the total removed by both sides, by the best files of two or three years ago.

If it was possible to produce such a remarkable improvement in the hand file, simply because of the use of an adequate testing appliance, what might be the result in many other lines of manufacture if rigid efficiency tests were impartially carried out? We all have learned that efficiency, so-called, is only comparative, and that no one can say anything has reached ultimate efficiency. Now that attention has been called to that simple yet perplexing tool—the file—it is entirely possible that its manufacture and action will not only be greatly improved but changed. In fact a radical change in file making has already been made by one British maker, which promises great improvement.

* * *

THE GROWING INEFFICIENCY OF WORKMEN.

A discouraging aspect of present industrial conditions is the inefficiency and general slackness of workmen in the building trades. The lack of the old-time pride in the mastery of a trade is very noticeable to one coming in contact with carpenters, plumbers, tinners, and others of the house-building trades. Not only do these workmen, in a great many cases, care nothing for their trades, but they rather pride themselves on being able to draw full pay for a minimum of knowledge and skill in their business. Not long ago the writer engaged a so-called carpenter to do a trifling job of interior work. The material cost at most 50 cents, and the time required was, say, two hours. The charge for the service was more than a first-class carpenter got for a full day of ten hours, ten years ago. The worst of it is that the job was of a grade that an amateur should have been ashamed of. This case is not merely individual; it is representative of a general state that is of grave import. The workman tries to do as little as possible for a maximum wage. Does he improve his condition by such action? No; on the contrary the general cutting down of productive capacity is one cause of the increase of cost of all building construction. Rents are higher because masons, brick-layers, carpenters, plumbers, tinners, roofers, painters, decorators, produce less. The consequence, of course, is a very substantial increase in the cost of living to all, for all must help pay.

The endeavor to better industrial conditions by reducing production is analogous to trying to lift oneself by one's boot straps. It is impossible to improve general conditions by reducing efficiency. *We believe in high wages and a full day's work.* The plumber who spends half a day putting a washer into a kitchen faucet is an encumbrance. He is essentially dishonest, and is a discouragement to the honest workman who would render honest service to his employer. It cannot be gainsaid, however, that the greed which would deny to workmen a just share of the profits accruing from their industry and general proficiency in manufacturing is largely responsible for creating the "ca-canny" spirit in America, a spirit which is the curse of Great Britain and which is reducing that country to a low level in the industrial scale. What will be the outcome here if there is no change for the better?

THEORY AND PRACTICE.

Many writers upon mechanical subjects, as well as many persons directly employed in mechanical work, treat the words theory and practice as if the ideas which these words signify were to be considered strictly apart from each other. They seem to consider that a distinct, clearly defined line can be drawn between the territories of theory and practice. It is a common error to speak of theory and practice as if they were in opposition to each other, the expression "right in theory, but wrong in practice," not being at all uncommon.

In the first place, there is really no defined line between theory and practice, and many a case could be cited where the theory of yesterday is the practice of to-day. Theory is nothing but an analysis of the laws which must be followed in practical work if that work is to be correctly carried out; and practice simply means the application of theory to the work carried out. Theory is nothing but common sense logically applied, and practice is the use of theory in productive work. In the second place, theory and practice can never disagree. If they do, then either the theory is incorrect, there is a flaw in its logic, and it ceases to be acceptable, or the common practice is wrong, and should be corrected to agree with the theory, logically arrived at by the application of common sense. While it is true that theory without practice would be useless, if it could be comprehended as existing in its extreme meaning, so practice without theory becomes next to useless, in our time at least, for it would signify only the rudest form of unskilled labor. While this is rather an unprofitable subject to discuss, still it is well to impress the idea that theory and practice cannot be considered apart, and that when it is done, it is liable to cause a confusion of ideas.

On the other hand, it is true that one may, with propriety, speak of things as being theoretically correct and commercially correct; the latter expression then simply signifying that a certain article, while produced in a way that really is not the best practice if one desires to arrive at extreme accuracy, still is such as to answer the purposes for which it is intended. Thus a screw thread may seldom be theoretically correct, but it may be commercially near enough to the exact form to serve its purpose. But this usage of these words does by no means imply that theory and practice are in opposition to each other. They are complements of each other, just as the work of the brain complements that of the hand. No man ever worked entirely by his brain, just as no man ever worked only by his hands. Brain and hands cooperate constantly, although in different degrees. So also do theory and practice. And in the same way as any work done mainly by bodily labor is always the better done the more the element of brain enters, that is, the more common sense is used, so also, the more true theory used in practical work, the better the result; for, as one of our European contemporaries says, *nothing is more practical than theory.*

* * *

THE FAILURE OF THE SMALL CAPITALIST.

One of the notable features of a period of great prosperity, such as that we have experienced, is the large number of new firms of comparatively small capital which spring into being at just about the time the wave of enthusiasm reaches its height. Most of these enterprises are wrecked when the wave breaks on the jagged rocks in the succeeding recession. They are short-lived at the best, and their increase forms one of the surest of the danger signals announcing the coming of reaction. The cause of this phenomenon may be coolly and dispassionately studied, though a vast amount of personal suffering is involved in the individual cases of which it is composed.

The condition is readily explained. When the tide of business begins to rise, following a preceding ebb of business, it finds men of small means with their resources nearly exhausted by the strain of the stringency through which they have passed. Men of great capital and foresight, however, carefully discerning the sign of the times, are gradually extending their operations, adding to their capital from time to time as fast as they can make money from their business, or borrow it from the banks. Business increases rapidly by such operations as these, and the new-found prosperity begins slowly to work its way downward from class to class, until finally the working man himself finds that his wages are somewhat larger than they have been for some time, and he is at last able to lay up a little store from the surplus left, over and above his living expenses. If the individual working man has a fertile brain and a little energy, this unwonted surplus acts as a stimulant, exciting his imagination, and urging him on in the venturous path of engaging for himself in a small way in some form of business in which he believes he can make a success.

Now, in all probability, at about the time this resolve has been reached, the climax of the good time has already been attained. Men of larger means and broader outlook have already begun to draw in their lines closer, fearing the coming stringency, and all of this is done so quietly and silently that the small capitalist never realizes that the best is passed, and the worst is yet to come. From such conditions as these result the great crop of pitiful failures which have marked every period of depression the country has passed through. It would seem wise for the small capitalist to store up his enthusiasm within his breast, and his money in the savings bank, until the next depression is passed and the country has again laboriously commenced to climb to a succeeding period of prosperity. It will take more courage to start in business then, but it will be an evidence of greater wisdom.

The acute thinker, on meditating the cause of this phenomenon, will easily conclude that it represents only one more example of the truth of that motto we sometimes see displayed for sale in the picture store windows: "Ain't it —— to be poor!"

* * *

LIABILITY OF EMPLOYERS.

In connection with the editorial entitled "Liability of Employers" in the November issue of MACHINERY, engineering edition, it may be deemed proper to quote some figures as to the average amount of expense due to accidents and injuries to employes, for which employers are held liable. The Fidelity and Casualty Co., of New York, has compiled some figures on this subject in its *Monthly Bulletin.* These figures cover the years from 1893 to 1900, and refer to the experience of the principal employers' liability insurance companies. It appears from these figures that, taking the United States as a whole, and the average of all classes of occupations, the average loss per $100 of wages paid was as follows:

Year.	Average Loss through Employer's Liability per $100 of Wages Paid.
1893	25.5 cents.
1894	27.6 "
1895	28.5 "
1896	29.9 "
1897	31.9 "
1898	33.6 "
1899	37.7 "
1900	36.2 "

The increase seen in these figures for late years does not depend on greater number of accidents, but is, undoubtedly, mainly due to new legislation tending to increase the liability of employers. The figures given express the average of all occupations, and it is stated that the figures are larger than those which concern manufacturers only would be, as the losses are greater for contractors than for factories. On the other hand, the figures given represent actual losses, and not premiums which are paid to the insurance companies. These are by necessity higher, but it has been estimated that 40 cents per $100 of wages paid would, in a factory of the ordinary class, cover the cost of insurance. In other words, the expense involved to insure a man earning, say, $600 a year would be $2.40 per annum, or less than 0.8 cent per working day. Considering this small amount, and as the insurance is, in fact, finally paid by the employes themselves, through their productive labor, it may well be repeated that employers should not place themselves in opposition to legislative measures of the kind referred to. The effect on the industries of the country as a whole cannot help but be greatly beneficial, and the movement for increased interest in safety appliances will receive all the more recognition.

ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

Consul J. I. Brittain, at Kiel, suggests that, when writing to German firms, American business men should enclose sufficient postage to pay for replies. If one has no German stamps, he should enclose American 5 or 10 cent stamps. This tends to create a better feeling in the matter.

A correspondent to the *Times Engineering Supplement* states that the German government railways have a fund for payment of premiums to employes who invent any appliance which may be useful in railway practice, and that during the last traffic year $3,700 was paid on that account to employes.

In our engineering review of last month we made mention of the very extensive use of American machine tools in Great Britain. In connection with this, it is of interest to note a statement made by Consul F. I. Bright, of Huddersfield, England. According to this statement, two large Huddersfield firms are equipped to an extent of 75 per cent. with American machines.

It has been claimed that the highest speed ever attained by an automobile was that accomplished at the Brookland motor track in England, where a 200-horse-power Darracq car attained a speed, for a short period, of 115.4 miles per hour. However, at Ormond Beach, Florida, on January 26, 1906, a mile was covered at a speed of 127.5 miles per hour, and at Ostend, Belgium, a speed of 117.5 miles an hour was attained for one kilometer, July 14, 1906.

It has been stated officially that the *Mauretania*, sister ship of the *Lusitania* frequently referred to in our columns, during her trials covered 300 miles at an average speed of 27.36 knots, and that she covered the full course of the trial run, 1,200 miles, at an average speed of 26.03 knots. These are by far the highest speeds ever heard of in connection with ocean liners. The record speed 27.36 knots equals a speed of about 31.5 statute miles per hour.

Some experiments by Prof. Ira Hollis, of Harvard University, says the *Magazine of Commerce*, show that cork has a distinct value for increasing the frictional resistance of metallic surfaces in contact. The coefficient of friction of materials usually used for brakes—leather or metal—is only half that of cork. Cork inserts may be used to advantage on the brakes of street railway cars, and also on pulleys to increase the grip of the belts. It is found that cork wears down no faster than the solid socket in which it is embedded. Its frictional resistance, apparently, is but slightly diminished by oil or moisture.

Attempts have recently been made at Stockholm, Sweden, says *Engineering*, with a view of devising a simple method of distinguishing between ordinary tool steel and the high-speed variety. The latter contains chrome and tungsten in considerable quantities, and as these elements form colored compounds with certain reagents, it was hoped that it might be possible to determine if a given sample of steel was of the common or high-speed variety by applying to a polished surface of it an indicating paper, previously moistened in a suitable reagent. No success was, however, attained, but it was afterward observed that while ordinary tool steel dissolves rapidly in dilute nitric acid with a copious production of nitrous fumes, high-speed steels are unattacked, at least so long as the content of chromium does not fall below four per cent.

In an article in the *Electrical Review* (London) the author discusses the question of electric *versus* hydraulic elevators. From the point of safety, it is contended, there is no difference between these two classes of elevators, if made by responsible firms; but a great difference is claimed as to running expenses. If power for both elevators be purchased from a power company, when there is but one elevator, the cost of hydraulic power is about $40, electric power, about $15. If there are several elevators in the same building, the charges for water power are reduced, and the figures then are $20 for the hydraulic elevator, and from $15 to $6 for the electric, according to the price of electricity. The author finally quotes Sir William Preece as saying that the London post office has found that the relative costs of working electric and hydraulic elevators are as one to five.

We mentioned in our engineering review of last month the success of steam turbines in a recently built German torpedo boat. It is now reported that the German government has placed a contract with a prominent ship-yard in Germany for the building of a large cruiser which will cost between $8,000,000 and $9,000,000. The new vessel will be fitted with Parsons turbines, a decision which shows that the prejudice which formerly existed in official quarters against this type of machinery is being overcome. The remarkable superiority in speed attained by the turbine-driven torpedo boat previously mentioned, over a sister vessel fitted with reciprocating engines, and the trial performances of the turbine cruiser *Stettin*, which developed a speed of 25:8 knots, have evidently fully convinced German navy experts that the turbines are superior, at least where high speed is the primary object.

According to the *Times Engineering Supplement* of July 31, one of the interesting exhibits at the Ironmongery Exhibition recently held at Islington was a new brazing flux, called "castolin," the invention of Messrs. Wasserman & Co., Lausanne, Switzerland. It is a preparation for brazing cast iron. The preparation is in the form of paste, and is rubbed into the pores of the broken surfaces. The pieces are then accurately joined together and tied; they are placed in a fire, and when as warm as the hand can bear, more of the castolin is rubbed into the grooves of the fracture. It is then covered with borax and "castolot" solder, and is placed in the fire again until red hot and the solder runs freely, when it is allowed to cool slowly and the piece is polished. It is said not to require a special plant, is always ready for use, contains no oxides, can be applied by any one used to ordinary brazing, is unaffected by time, and will not break again in the same place.

A recent report by a committee appointed by the British Board of Trade indicates, according to the *Mechanical Engineer*, that British manufacturers do not place great confidence in large industrial exhibitions. The same sentiment among German manufacturers recently gave the death-knell to an organized movement for a large world's fair in Berlin, to be held in 1913. American manufacturers, judging from the slight interest taken in the Jamestown exhibition, evidently have come to a similar conclusion, that is, that the matter of great, or so called international exhibitions has been largely overdone. After the failure of the Jamestown exhibition to arouse any interest worth mentioning, it is to be hoped that our government will, for a long time to come, refrain from aiding schemes of this kind, which so little benefit our industries. Specialized exhibitions on a smaller plan are of far greater value to both the manufacturer and the public.

Some newspaper writers like to tell a great deal about Europe being rather "slow" as compared with industrial America. A note in *Engineering*, however, seems to indicate that at times they perform over there some feats that have hardly ever been equalled here. The fitting of the machinery to the steamship *Peiho* by Barclay, Curle & Co., Ltd., is probably a record in its field. The machinery consisted of triple expansion engines having cylinders, 26 inches, 45 inches, and 76 inches in diameter with 54 inches stroke, and four single-ended boilers working at 200 pounds pressure. The boilers

were put in between 6:30 and 8:30 P. M., a Friday afternoon. The whole of the work in the stoke-hole, including the fitting of funnel and ventilators, was completed in less than eight hours on Saturday. On Monday morning the work of putting the engines in place was started, and at 5 P. M. in the afternoon the work was completed. This, it must be admitted, would make even our own "hustlers" work hard to equal.

A project of daring dimensions has, according to the *Oesterreichische Wochenschrift für den Oeffentlichen Baudienst*, been considered by the International Navigation Congress. This project involves no less an undertaking than a trans-Alpine waterway, consisting of a canal from the Danube at Vienna to the Adriatic at Triest. The initial expenditure has been assumed to amount to from $120,000,000 up to as much as $300,000,000, but as this waterway would be a link in a chain of waterways connecting the Baltic with the Adriatic, it has been estimated that it would accommodate an enormous freight traffic. The canal would have to be constructed with twenty-two tunnels of a combined length of nearly six miles. There already are, in Europe, some large canal tunnels, notably one on the Marne-Saone canal, where one tunnel is nearly three miles long and over 700 square feet in section, and one on a canal, at Condes, which is about 1,000 feet long and over 1,100 square feet in section. The cost of these tunnels is at the rate of about $1,000,000 a mile.

Consul-General R. J. Wynne, of London, in referring to the new British patent law, which goes into effect on January 1, 1908, quotes the following, which will be of direct interest to American machinery builders: If a patented article or process be manufactured or carried on exclusively or mainly outside the United Kingdom, then, unless the patentee prove that the patented article or process is manufactured or carried on to an adequate extent in the United Kingdom, or give satisfactory reasons why it is not so manufactured or carried on, the comptroller may make an order revoking the patent forthwith, or he may make an order revoking it after a specified interval if the patented article or process be not in the meantime adequately manufactured or carried on within the United Kingdom; but in the latter case, if the patentee give satisfactory reasons for the failure so to manufacture or carry on within the prescribed time, the comptroller may extend the period by not more than one year. To obtain such an order, application must be made to the comptroller at least four years from the date of the patent and one year from the date of the patent and one year from the passing of the act; moreover, any decision of the comptroller is to be subject to an appeal to the High Court, and no order is to be made that will be at variance with any treaty, convention, arrangement, or engagement with any foreign country or British possession.

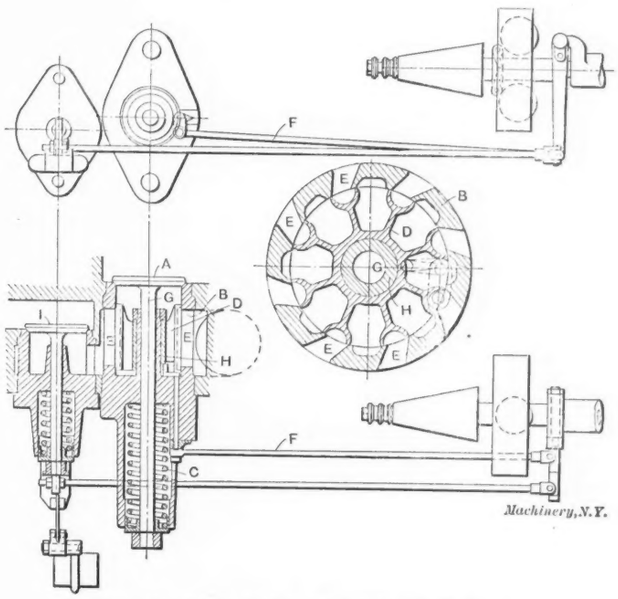
In an article on making steel and killing men by Mr. William Hard, published in the November issue of *Everybody's Magazine*, a terrible indictment is found against the managers of steel-making concerns for great loss of life and limb. During the past year, forty-six men were killed in the South Chicago plant of the United States Steel Corporation, and in no case was there a great casualty; there were forty-one separate accidents resulting fatally. But this is not all. One-hundred-eighty-four were disabled for at least thirteen weeks, and three-hundred-ninety-eight were disabled permanently. Of minor accidents, there were many hundreds more. The prime cause of these accidents is contributory negligence on the part of those injured and their fellow workmen. For example, it is a common practice to lift a slag-pot with the crane chains hooked to the rim of the pot rather than to lugs with which these pots are supposed to be provided. But, avers the author, if the company was made liable to pay a flat fine of $20,000 for every fatality, it is a moral certainty that slag-pots would not be lifted by their rims. Why? Because the company would make it a point of business to insist that this and all other similar dangerous practices be stopped. Now its business is making steel and the safety of human life is merely a secondary consideration. It is cheaper to kill and maim than to provide against accidents.

GOVERNING DEVICE FOR INTERNAL COMBUSTION ENGINES.

The Mechanical Engineer, October 19, 1907.

Internal combustion engines are commonly governed by throttling the admission of gas and air into the cylinder in such a manner that when working at full load the working fluid is admitted freely into the cylinder and practically a cylinder full is drawn in to form each working charge. As the load decreases the throttling of the admission causes a less quantity to be drawn in, and less than a cylinder full forms the charge for the next impulse of a reduced power, the degree of the throttling and the quantity drawn in to form a charge being varied by the governor.

An arrangement for obtaining the desired amount of throttling is shown in the accompanying cut. The admission valve *A* is arranged in a casing *B*, and is operated by a cam and lever, moved inward by means of the lever, and returned to its seat by means of a spring *C*, the opening of the valve *A* taking place during each suction stroke. The inner portion of the casing *B* is arranged with a number of parallel slots *E* through which the working fluid is drawn before passing



Governing Device for Internal Combustion Engines.

through the valve *A* into the cylinder. A light rotary valve *D* is provided, having as many arms as there are slots *E*, the outer edges of these arms being spread out so that in one position the slots are entirely covered. When in this position, although the admission valve may open in the ordinary manner, only as much of the working fluid can gain admission to the cylinder as will be allowed by leakage past the edges of the outer portions of the rotary valve *D*. The valve *D* will be moved into this position by the governor only when there is a light load on the engine. Should the load increase, the governor, by means of the rod *F*, rotates the valve *D* and opens the ports *E* to any desired extent. The outer end of the arms of the rotary valve *D* are hollowed so as to present only small fitting edges, thus reducing friction and risk of sticking. The ports *E* also have narrow fitting edges for the same reason. As it is not desirable to carry this method of governing down to very light loads, it is worked in combination with the ordinary hit-and-miss governing which comes into operation whenever the engine runs on very light loads, as indicated in the cut. It is not necessary therefore that the rotary valve *D* should do more than throttle the working fluid to a moderate extent, and it may therefore be left free in its movement, thus allowing the governor to move it with ease. The rotary valve *D* may either rotate upon the spindle *G* of the admission valve *A*, or upon a sleeve *H* through which the spindle of the admission valve moves, this latter arrangement being shown in the cut. The governor may be arranged so as to operate the hit-and-miss governing as well as the partial rotation of the valve *D*, as is also shown.

TESTS OF EMERY GRINDING WHEELS.

Mitteilungen über Forschungsarbeiten, No. 43, 1907.

On behalf of the Verein Deutscher Ingenieure, and with the assistance of Messrs. Ludwig Loewe & Co., of Berlin, Germany, Dr. G. Schlesinger has conducted some tests on the durability and safety of emery grinding wheels. One of the objects of the research was to demonstrate that the regulations laid down by the Prussian Government in 1897 as to the maximum circumferential speed of such wheels—*viz.*, 82 feet per second—should be relaxed. The manufacture of emery wheels had at that time been taken up by incompetent and inexperienced men, and serious accidents had occurred, so that restriction was needed. The emery wheels and the grinding machines have, however, been so much improved of late that a revision of the regulations appeared opportune.

Dr. Schlesinger has, in his trials, adopted workshop conditions, except that he disregarded the safety regulations prescribed by law. Most of the twenty-eight wheels experimented upon were not especially ordered, but taken from the stocks of good firms. The wheel and the test-piece, of cast iron, wrought iron, or steel, were both rotated, and the experiments continued during ten hours for two or four days. The experiments lasted three months. No accident occurred, and in no case did the wheel fly apart, although the speed was raised to the maximum which the driving electric motor permitted. Under the continued strain the wheels began to crumble, emery grains breaking off. The wheels were cylindrical, 20 inches in diameter and 2 inches in width, and were revolved at speeds of 82, 99 and 115 feet per second. The test-piece was fed along at different rates, as a rule ½ to 1 inch per revolution of the test-piece, which was revolving at a maximum circumferential speed of 99 feet per minute. In extreme cases the grinding wheel absorbed 30 horse-power, while in practice 6 horse-power will hardly be exceeded.

The emery wheels were run wet during the experiment, and those wheels which allowed the water dripping upon them to percolate as if they were porous sieves answered, on the whole, best. In this respect the cement used for binding the emery grains is very important. In order to assist the purchaser, Dr. Schlesinger suggests that every emery wheel should bear a notice stating whether the wheel is to be used dry or wet, that it has stood a circumferential speed of 165 feet per second, but that it should not be used at any speed exceeding 115 feet per second.

INDUSTRIES OF BIRMINGHAM.

Derrick's British Report, August, 1907.

Birmingham is the third city in England, and her population has risen in a hundred years from 90,000 to 500,000, but within a distance of twelve miles from the town hall there dwell over a million people. It is built on an elevation, the huge teeming workshops, factories and warehouses, being in the lower parts of the town. It is the principal center of metal manufacture, the industry consisting of the production of an infinity of articles in gold, silver, brass, steel, etc. The manufacture of small arms has become a very important department of enterprise in recent years, hundreds of thousands of gun barrels being tested annually at the local gun-proof offices. The manufacture of engines and boilers has allocated to it a premier place in Birmingham's characteristic industries, the largest works being in a district known as Soho, lying to the northwest of the city, where Watt and Boulton made the first steam engines ever employed in British industry. There are extensive and flourishing chemical works, and the cycle trade competes with that of Coventry, the chief cycle center of Britain, distant but a few miles.

Birmingham has been termed the workshop of the world, as it has a greater variety of manufactures than any other city. These comprise iron and brass founding, rolling, stamping, plating and drawing of metals; manufacture of jewelry; pearl buttons; hooks and eyes; studs; cycles and cycle fittings; railway wagons and carriages, coach and railway lamps; cricket bats and sports outfits; perambulators and mail carts; wire; steel pins; metal bedsteads; art metal work; fenders; coaches; air guns and rifles of every kind; tools and machines; keys, screws, bolts, locks; plate glass; fancy leather goods; spectacles; umbrellas; furniture; gas and electric fittings; electro-plating and gilding; bell-founding; fancy aluminum goods; greenhouse and garden requisites, etc.

A great bulk of the bronze and copper coin of Britain is coined in the city for the Imperial mint. Birmingham also mints an important value of similar coin for other countries. The city also claims to be the largest hardware manufacturing center in the world. Within the place and its environs there is made everything from a pin to a hundred-ton gun, a pagan brass god to an anchor for a man-of-war. Birmingham has the distinction of being the world's metropolis for over a dozen distinctive branches of manufacture. The epithet "Brummagem," which at one time conveyed the idea of something cheap and unreliable, no longer has force or point.

A feature connected with the prosperity of Birmingham, and one that distinguishes it from other large industrial centers in the kingdom, is the absence of any marked contrast in the wealth of the people. In Manchester, Liverpool or Leeds you find merchants or manufacturers of immense wealth; a numerous and affluent middle class; the operative earning masses with sufficient to live in comfort and save money, the scale terminating with a sprinkling of shiftless, improvident nonproductive people. Birmingham has been described as a place of small fortunes, the meaning being that there are more examples of the skilled mechanic or other operative who has, through some special knowledge of a branch trade or minor industry tributary to a large enterprise, succeeded in starting out in business as his own master and prospering therefrom. For instance, a large manufacturing concern employs in the building or construction of, say, a machine or other complex production characteristic of Birmingham, an infinity of processes, parts of structure or methods of treating material. It is competent for the mechanic or other artisan, who formerly undertook the mentioned work as an employe, having saved, or in other ways accumulated, a small capital, to establish himself on his own footing, his best customer not infrequently being his aforetime employer.

For example, suppose that a man has been engaged for years as an employe in turning out the bosses or the small rollers for bedsteads. The material and the necessary machinery perhaps are not expensive; the chief items of stock-in-trade are the skill and knowledge of the artisan himself; so that the whole circumstances are such as to enable the man of modest capital to become a master. Birmingham is noticeable for the prevalence of this class of manufacturer—the man of small fortune made out of a tributary industry.

THE PRESENT POSITION OF THE GAS ENGINE.

Paper by Mr. Dugald Clerk, read before the British Association.

In this paper the author first reviews the present condition of the gas engine industry in Great Britain. Engines of small and moderate powers are built in large quantities, and the principles that have to be followed in their design have been thoroughly investigated, and a type, almost standard, has been arrived at. The author understands small and moderate power gas engines to be those with less than 100 horse-power per cylinder. At the present time, about 300 such engines are turned out in Great Britain per week. These engines are recognized to be as reliable as the best steam engines of similar dimensions, and to be more economical. The small engines mostly use coal gas, and the larger, producer gas. With regard to large gas engines, British engineers have assumed the conservative attitude (and so, as we know, have American manufacturers as well), but experience in the design of larger units is constantly being acquired. English designers have always felt the desirability of keeping down cylinder dimensions as much as possible, on account of a general recognition of the fact that there are practical difficulties with large diameter cylinders, due to unequal expansions in the cylinder metal resulting in cracking, and also because of the appreciation of the fact that increase in cylinder dimensions and other details of the unit require an expenditure in metal and workmanship, the amount of which grows in a proportion having a far greater acceleration than the increase of the power obtained. The two main problems met with in large gas engine design may be stated as follows. The one is to build engines

of large power which will be reliable and be able to run economically for long periods without breakdowns, and the second is to be able to build such engines at such a cost as to enable them to compete effectually with steam engines, even in the matter of first cost. The first of these problems has been satisfactorily solved on the European continent, but it has been recognized that the solution of the first problem has involved weights of material and cost of construction which have almost left the second problem out of consideration. The author stated as his personal opinion that he did not think that the tremendous units of gas engines which of late have been designed on the Continent were commercially desirable, and he thought that there were difficulties preventing a successful competition of gas engines with steam engines of greater power than about 500 horse-power, excepting in cases where the gas engines could be operated with blast furnace gas, in which case the cheapness of the fuel made these engines desirable. If gas engines are to be run with producer gas, the fuel is rather expensive for large units, if it has to be produced out of anthracite, and no really satisfactory producer has been constructed for producing gas from bituminous coal.

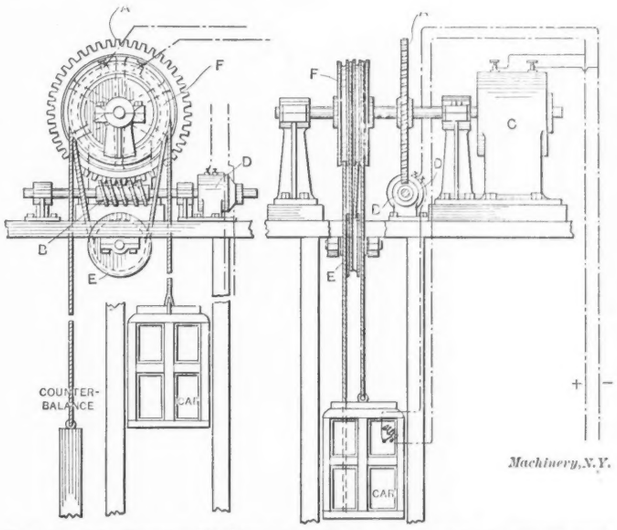
One of the main difficulties in the design of large gas engine cylinders is the contradictory conditions required for obtaining sufficient strength, and at the same time permitting the cooling of the cylinder. The enormous pressure in the large units require thick castings, but, in order to allow the heat to be carried away from the cylinder walls to the water in the water jacket, thin castings are called for. Engines of small dimensions do not present this difficulty, but where the metal is required to be about three inches thick in order to resist the internal pressure, the difference between the temperature on the inside of the cylinder and on the water side becomes serious, and great stresses are set up in the walls, which finally lead to the cracking of the casting. It has been found that cylinders 50 inches in diameter are too large in ordinary gas engine design, and nothing but the highest skill in designing, and the greatest care in choice of material, enable such cylinders to withstand, for any length of time, the severe stresses to which they will be exposed when in use.

[In this connection, it may be proper to call attention to some figures in regard to the operation of gas and steam engines as stated in a late issue of the *Practical Engineer*. Here the author, in discussing the commercial efficiency of high power reciprocating steam engines compared with that of gas engines for driving electric generators, points out that the efficiency of the gas engine, unlike that of the steam engine, does not increase in proportion to the increase of power, and that above a certain power, the cost of gas engines, per horse-power produced, is almost independent of the number of units adopted. If, therefore, a plant of 4,500 horse-power be taken as an example in order to make a comparison between two types, while the steam engines may be properly made in say three units each of 1,300 horse-power, the best results for gas engines may be obtained with six units of 750 horse-power. The following figures tend to show that a gas engine installation is the cheaper, as the cost per kilowatt hour, including depreciation and working expenses, for the steam engines varies between 0.524 cent and 0.742 cent, while for gas engines supplied with high-temperature furnace gas, the same cost would amount to only 0.178 cent, and that for a gas engine with producer gas supplied with coal at $3 per ton would be 0.406 cent. Of course, these figures refer to British conditions. The figures for American conditions would surely be considerably higher, but there is no reason why there should be any difference in the proportion between the costs of the steam engines and gas engines.]

HIGH-SPEED ELEVATORS.

At the regular monthly meeting of the American Society of Mechanical Engineers, held November 12, Mr. Charles R. Pratt presented a paper on high-speed elevators in which he called attention to certain dangers existing in gearless 1-to-1 traction electric elevators as now built, and described the construction of his new elevator machine, designed to overcome the dangers pointed out. The type of elevator selected for the new Singer Building and the tower of the Metropolitan Life Insurance Building, is of the older gearless 1-to-1 traction type, the driving mechanism being a motor located over the hoistway with a traction sheave and a brake pulley mounted on its armature shaft. The ropes from the car pass over the traction sheave down under an idler sheave and again over the traction sheave, thence to the counterbalance, thus giving two half traction turns over the sheave to drive the car and counterbalance. The accompanying cuts, Figs. 1 and 2, illustrate the general scheme so far as the arrangement of the sheaves and motor is concerned.

The diameter of the traction sheave is about 40 inches, which is the least permissible for proper wear of the size of ropes used. The diameter gives a circumference of about 10½ feet. Running at normal speed a motor of about 50 horse-power is required to handle a net load of 2,000 pounds, lifting at a speed of 600 feet per minute. However, if it runs at the low speed of 57 revolutions per minute a motor of about 200 horse-power size, cost and weight will actually be required. The loss of motor efficiency, however, is more than compensated for by the elimination of friction. This elevator



Figs. 1 and 2. Elevator Machine of the Type to be used in the Singer Building, showing Pratt's Safety Device, which is not part of that Installation.

machine is a product of elimination throughout, all unnecessary frictional parts having been discarded, and it eliminates:

a. Friction of worm, spur, screw or rope and sheave gearing.
b. Excessive size of winding drums.
c. Dependence upon automatic limit stops.
d. Inertia of large moving parts of metal and water in hydraulic elevators.

Experiments made by the author on this form of traction rope drive using iron wire hoisting ropes running in smooth round grooves in the traction sheave with from 1½ to 7½ half traction turns demonstrated that the least traction obtained is with new dry ropes on new dry grooves. After considerable use there is not 5 per cent difference in traction between a dry rope and a rope flooded with lubricant. Thus, the fact is established that if this elevator will handle its full load when first started with new ropes, it will always handle its full load safely.

This type of elevator has two distinct advantages over all others, being, unlimited rise and safe normal limit stops. Its unlimited rise is obvious. Its safe normal limit stops are due to the landing of the car or counterbalance on buffers. When either the car or the counterbalance reaches the bottom of the hoistway the tension on its rope leading to the traction sheave is so reduced that all traction is lost and the motor and sheave can keep on revolving with no further travel of car or counterbalance.

The new Singer Building and the Metropolitan Life Insurance tower call for a speed of 600 feet per minute at a rise of 500 feet and over. The selection of the elevators of the Metropolitan Life Insurance building was referred to a most distinguished board of engineers, *viz:* Messrs. Mailloux, Knox, Spangler, Knight and Duenkle, and the gearless 1-to-1 traction elevator was selected. The author then stated that although

the gearless 1-to-1 traction electric elevator has been used in high-class passenger elevator service but a few years, its success proves the merits indicated in theory. There have been no accidents to suggest danger, but in his opinion there has been two most important elements of safety neglected, *viz:* positive speed control and holding power. The brake pulley, being of the same or but little larger diameter than the traction sheave, must have a frictional resistance at the brake shoes, when the brake is on, equal to the net load. The brake and motor are alternately deprived of their motive and holding power every few seconds. Should one happen to let go before the other takes hold, the car falls free to the bottom of the hoistway unless checked by some safety device. There is no positive means to hold a car or prevent it attaining a dangerous speed.

Mr. Pratt's patent No. 865,205, dated September 3, 1907, is designed to take care of these danger elements. The safety feature consists briefly of a worm-wheel *A*, Figs. 1 and 2, mounted on the armature shaft. Meshing with this worm-wheel is a worm *B* driven by a small auxiliary motor *D*. The main and auxiliary motors are worked from a common controller, and start and stop together. The pitch of the worm is such that the worm-wheel cannot over-run. If the small motor does not run, the main motor cannot turn the armature shaft. The effect is obvious. The auxiliary motor must run in step with the main motor, although it does little or no actual work in lifting or lowering the load. It simply operates as a positive lock, the lock always being in engagement with the worm-wheel yet running at such speed as to offer no retardation save at starting and stopping. The auxiliary motor working under no load tends toward perfect acceleration, and it tends to stop the car without jolt.

The advantages claimed for the gearless 1-to-1 traction electric elevator, with the Pratt improvements, are as follows:

a. Positive limit stops.
b. Absolute limit of speed.
c. Perfect acceleration.
d. Shortest possible distance in starting and stopping.
e. Perfectly smooth action.
f. Dead lock at stop position.
g. Highest possible rise and speed.
h. Little space occupied.
i. Low cost of installation.
j. Low cost of operation.
k. Perfect safety.

The difficulty with this device lies in controlling the auxiliary motor so as not to consume a great deal of energy in friction and lost work. The author states that two electric motors can operate without interference when positively geared together, as witness the design of the Central London Railway elevators by Mr. Frank J. Sprague, and intimates that no real difficulty exists in securing coördinate action in this case.

STANDARD PROPORTIONS FOR MACHINE SCREWS.

Abstract of Report presented before the American Society of Mechanical Engineers, May Meeting, 1907.

A committee appointed by the American Society of Mechanical Engineers to investigate the subject of machine screw proportions and to recommend standard specifications for machine screws, made its first report at the December meeting, 1905. Some criticism, however, of this report made it necessary to call for a second, and what was intended to be a final, report at the May meeting, 1906. (See June, 1906, issue). In the discussion that followed this report there were, however, several diverging opinions expressed on this subject, and the committee was therefore continued and was supposed to report at the December meeting in the same year. For some reason the report, however, was not accepted by the Association before the Indianapolis meeting in May of this year. In connection with the tables given in the present data sheet supplement, we herewith present some of the most important points of consideration in the new standard for machine screws which has been accepted by the American Society of Mechanical Engineers.

The standard diameters of machine screws are to be 21 in number. The included angle of the thread is 60 degrees, and the flat at the top and bottom of the thread for the basic

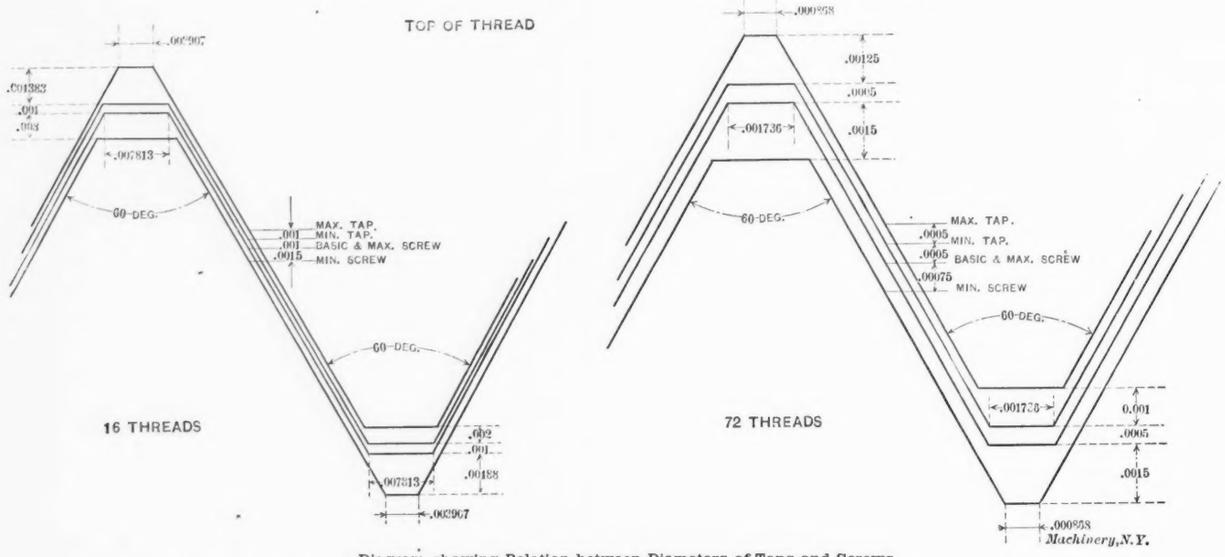


Diagram showing Relation between Diameters of Taps and Screws.

standard is ⅛ of the pitch. The uniform increment between all sizes from 0.060 inch to 0.190 inch is 0.013 inch, and for larger sizes 0.026 inch, making the largest size 0.450 inch in diameter. The number of threads is made a function of the diameter as expressed by the formula

$$\text{Number of threads per inch} = \frac{6.5}{D + 0.02}.$$

This formula, however, gives the results approximately only, as even numbers of threads are chosen in order to avoid fractional or odd numbers.

In regard to the limits for variation from the basic standard, the maximum screw shall conform practically in all respects to the basic standard. The minimum screw shall have a flat at the bottom of the thread of 1-16 of the pitch, and the difference between the maximum and minimum root diameter will allow at the bottom of the thread any width of flat between 1-16 and ⅛ of the pitch. (See cut). The maximum tap shall have a flat at the top of the thread equal to 1-16 of the pitch, and the difference between the maximum and the minimum external diameter will allow at the top of the thread any width of flat between 1-16 and ⅛ of the pitch. The minimum tap shall conform to the basic standard in all respects except in diameter, as plainly shown in the cut. The difference between the minimum tap and the maximum screw is settled upon in order to allow for errors in pitch, and for the wear of the tap in service. The formulas in Table I give the relation between the various dimensions determining the sizes of taps and screws in this standard.

The reference thread gages should be made from unhardened steel, 0.35 per cent carbon, and a set should include both reference thread gages for screws and reference thread gages for taps, each of these to represent the maximum and minimum diameters. Table II gives the thickness of double end

TABLE I. FORMULAS FOR PROPOSED STANDARD FOR MACHINE SCREWS AND TAPS. BASIC STANDARD THREAD, U. S. FORM.

T. P. I. = Number of Threads per inch.

SCREWS.

Max. External Diam. = Basic External Diam.

Max. Pitch Diam. = Basic Pitch Diam.

Max. Root Diam. = Basic Root Diam.

Min. External Diam.

$$= \text{Basic External Diam.} - \frac{0.336}{\text{T.P.I.} + 40}$$

Min. Pitch Diam.

$$= \text{Basic Pitch Diam.} - \frac{0.168}{\text{T.P.I.} + 40}$$

Min Root Diam.

$$= \text{Basic Root Diam.} - \left[\frac{0.10825}{\text{T.P.I.}} + \frac{0.168}{\text{T.P.I.} + 40}\right]$$

TAPS.

Max. external Diam.

$$= \text{Basic External Diam.} + \frac{0.10825}{\text{T.P.I.}} + \frac{0.224}{\text{T.P.I.} + 40}$$

Max. Pitch Diam,

$$= \text{Basic Pitch Diam.} + \frac{0.224}{\text{T.P.I.} + 40}$$

Max. Root Diam.

$$= \text{Basic Root Diam.} + \frac{0.336}{\text{T.P.I.} + 40}$$

Min. External Diam.

$$= \text{Basic External Diam.} + \frac{0.112}{\text{T.P.I.} + 40}$$

Min. Pitch Diam.

$$= \text{Basic Pitch Diam.} + \frac{0.112}{\text{T.P.I.} + 40}$$

Min. Root. Diam.

$$= \text{Basic Root. Diam.} + \frac{0.112}{\text{T.P.I.} + 40}$$

templet thread gages, for each pitch of the standard screws recommended, for the practical inspection of machine screws. The formula

$$\text{Thickness} = \sqrt{\text{pitch}} \times 1.443$$

provides a limit for the error in lead on screws and taps. These templet thread gages are to be made of steel, hardened, and being double ended and having maximum and minimum limits, respectively, are to represent at the largest end the pitch and root diameters of the basic standard, while at

TABLE II. DOUBLE END TEMPLET THREAD GAGES FOR INSPECTION OF SCREWS.

Thickness = $\sqrt{\text{Pitch}} \times 1.443$

Threads per inch	Thickness	Threads per inch	Thickness
80	0.161	30	0.263
72	0.170	28	0.273
64	0.180	24	0.295
56	0.193	22	0.308
48	0.208	20	0.323
44	0.217	18	0.345
40	0.228	16	0.361
36	0.240	14	0.385
32	0 255	..	.....

the small end they should represent the minimum limits for the pitch and root diameters of screws. The threads of these templet gages should be made by taps having the thread enough larger than the standard in the outside diameter to insure clearance at the top of the thread of the screw. In addition to the threaded holes, these gages should have plain cylindrical holes representing, respectively, the external diameter of the maximum and minimum screw.

BALL BEARINGS.—1.

Abstract of Paper by Henry Hess, presented before the American Society of Mechanical Engineers, May Meeting, 1907.

Although the field of usefulness of the ball bearing is as wide as the domain of mechanical engineering, but little information on ball bearings can be found in the engineering hand books or text books. Generally the subject is dismissed with occasional reference. Sometimes a formula for carrying capacity is given, but this is usually wrong. There is of course much matter scattered through the technical press giving isolated experiences with a few bearings that happen to come within some one's observation. But, undoubtedly, the insufficient information on the elements of ball bearings is responsible for the directly contradictory statements to be found, and the generally accepted opinion that ball bearings are suitable only for comparatively light loads. This was the situation found by Prof. Stribeck, a German investigator, who has been experimenting with ball bearings for the German Small Arms and Ammunition Factories, of Berlin. The present paper is a résumé of Prof. Stribeck's report, together with a number of notes based on the author's experience.

The Wear of Ball Bearings.

Sliding bearings wear out by abrasion of the carrying surfaces, but ball bearings do not give out on account of wear. In fact, they do not wear. They may be ground out by admitting grit, but that is an abnormal condition for ball bearings, the same as it would be for sliding bearings. The only normal cause for the giving out of ball bearings is the stress on the material, when this stress exceeds certain limits. Lightly loaded bearings can be so designed as to eliminate this cause altogether, and to insure practical indestructibility. In heavily loaded bearings this condition may not be possible to realize within practical dimensions, but the proportions may be so chosen that the stress will not cause a break-down within the lifetime of any mechanism to which the ball bearing is applied. An important principle in the design of ball bearings is that the balls may be subjected to loads, increasing as the shape of the supporting surface more nearly becomes complemental to that of the ball. A ball running between races having a flat or straight line cross section will not support as great a load as if the section were curved, or in other words, if the balls were running in a groove. The groove, of course, must never have a curvature equaling that of the ball, as that would substitute sliding for rolling contact.

Formulas for Loads on Ball Bearings.

The frictional resistance of a ball bearing is lower the less the number of balls. Bearings should be designed to have between 10 and 20 balls. For this number of balls the equation

$$P_o = \frac{5}{z} P_b \qquad (1)$$

should be used. In this equation

P_b = total load on the bearing consisting of one row of balls, in kilograms.

P_o = greatest load on one ball, in kilograms.

z = number of balls.

The load carrying capacity of a ball is $P_o = k\,d^2$, in which

d = the ball diameter, in eighths of an inch,

k = a constant depending upon the material and shape of the ball supporting surface. This constant should vary between 3 and 5 for common materials for ball bearings and between 5 and 7.5 for improved steel alloys.

As balls are usually made to English measurements, one-eighth inch has been selected as unit for the ball diameters.

From equation (1) we have

$$P_b = P_o \frac{z}{5}, \text{ and substituting } k\,d^2 \text{ for } P_o, \text{ we have}$$

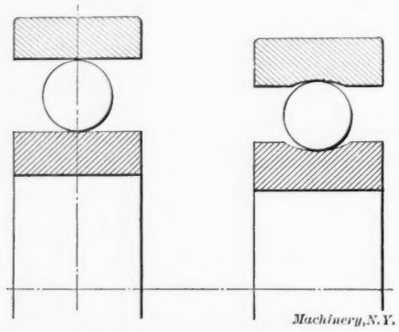
$$P_b = k\,d^2 \frac{z}{5}$$

Speed rotation, in as far as it is uniform, does not affect the carrying capacity of a ball bearing. This applies, however, only to radial bearings, but not to thrust bearings of the collar type. In these, the carrying capacity decreases with the increase of speed. Variations in load reduce the

carrying capacity, the effect increasing with the amount of load change and the rapidity of the change. Uniformity of ball diameter is very essential as the calculated carrying capacity can be realized only if each of the balls sustains its share of the load. High finish on both ball and ball sustaining surfaces is also essential. The presence of grinding scratches will very materially cut down the load carrying capacity.

Frictional Resistance of Ball Bearings.

The frictional resistance of ball bearings has, by actual measurement, been found to vary from 0.0011 to 0.0095. These are the coefficients of friction referred to the shaft diameter, thus permitting direct comparison with coefficients of sliding friction. Ball bearings having a coefficient of friction materially above 0.0015 under the greatest allowable load should not be recommended, because they are too short-lived. The high resistance indicates the presence of too large an element



Figs. 1 and 2. Example of Simple Radial Bearings.

of sliding friction. The coefficient of 0.0015 for a good ball bearing under its greatest load, independent of the speed within limits, will, however, rise to approximately 0.0030 under a reduction of the load to about 1/10 of the maximum.

The Requirements of a Good Ball for Ball Bearings.

The requirements for a good ball are, in the first place, truth of shape and size. The permissible limit of error will vary with the character of the material. It is evident that where a ball is larger than the other balls in the bearing, it must be capable of a deformation sufficiently large so as to permit the others to carry part of the load, and for that reason, the smaller the deformation, the more accurate to size must the ball be. In the second place, a high degree of surface finish is essential. What is usually considered a very good finish is in a ball bearing totally inadequate. Grinding and polishing marks must not only not be recognizable by the naked eye, but, if detected with an ordinary pocket lens, the balls should be condemned. This, at least, is true of balls for bearings expected to have long life, and to carry heavy loads under high speed. The third condition for balls is that the material out of which they are made has an elastic limit as high as can be had. The uniformity of

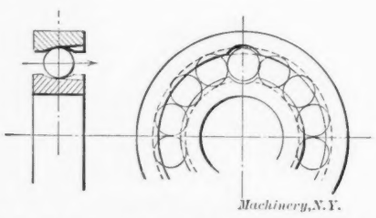


Fig. 3. Objectionable Filling Groove in Ball Bearing.

hardness throughout the mass of the ball is also very essential. General uniformity, in fact, is one of the most important factors, for it will not do to say that because some balls in a lot are better than the others, the design may be based on the poorer ones. Such reasoning would result in the better balls carrying more than their share of the load, producing too heavy a stress, and possibly breakage, of these balls. Lower quality, provided it is uniform, is better than such a condition. The limits of error in regard to the truth and size should not exceed 0.0001 of an inch.

Radial Bearings.

Other things being equal, it is always best to arrange sustaining surfaces at right angles to the load direction. That gives a design of bearing such as shown in Fig. 1, but a better carrying capacity is to be had from the modifications shown in Fig. 2, in which the ball races have curved cross section instead of straight lines. The grooved races have the advantage of greater sustaining capacity, as has already been mentioned. Cutting a local groove from one side into the races, as in Fig. 3, for the purpose of assembling the balls between

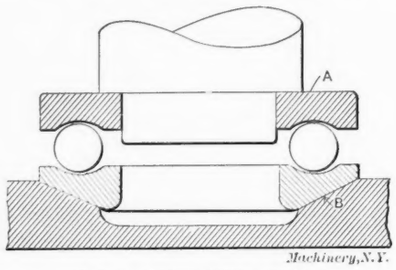
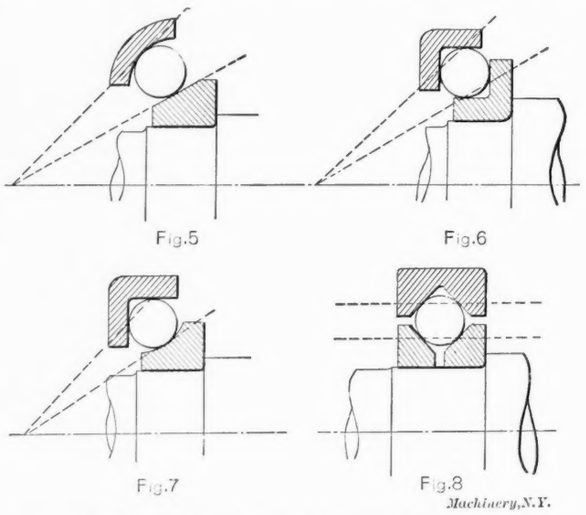


Fig. 4. Collar Thrust Bearing.

the two races, is common practice, but it is not good practice. So long as the loads are low enough, a filling opening may be of no account, but at high speeds and loads this groove is objectionable, since then the catching of the balls at the junction of the filling groove results in damage to the balls and through these to the race surface.

Thrust Bearings.

In thrust bearings, of the type shown in Fig. 4, the requirement that the sustaining surface should be at right angles to the direction of the load is provided for. These bearings are frequently made with the surfaces *A* and *B* parallel. Providing that these surfaces are made truly parallel, that design is good, but in practice it is seldom possible to get these surfaces truly parallel, because even if such parallelism were



Figs. 5, 6, 7 and 8. Example of Angular Bearings.

possible of attainment, it could not be maintained under the deflections due to the load. It must be remembered that initial errors or deflections of a thousandth of an inch will cause the balls on one side to carry the entire load. For a given case this would demand bearings of larger size than otherwise necessary. By seating one plate on a spherical surface as shown at *B*, Fig. 4, the lower plate can adjust itself in such a way as to distribute the load over the entire number of balls. The speed at which these bearings are run enters decidedly into the carrying capacity of this type of bearing. The utility of these bearings is greatly reduced when speeds exceed 1,500 revolutions per minute.

Angular Load Bearings.

The shapes and modifications of angular load bearings are innumerable. Figs. 5, 6, 7, and 8 may be taken as typical instances of these bearings, representing 2, 3, and 4-point contacts. In order to secure rolling contact, the contact points

of balls on races should form points on a cone of rotation whose apex lies in the center line of the shaft, or they may form points on the surface of an imaginary cylindrical roller that would be parallel to the shaft. The defect in all these forms of bearings is their adjustable feature. This places them absolutely at the mercy of every one capable of handling a wrench. A bearing properly proportioned with reference to a certain load may be enormously overloaded by a little extra effort applied to the wrench, or on the other hand the bearing may be adjusted with too little pressure, so that the balls will rattle, and the results consequently be unsatisfactory. The prevalent idea that angular ball bearings can be adjusted to compensate for wear is erroneous. The wear will form a groove on the loaded side of the race, deepest at the point of maximum load, and adjusting the cone endwise will only cause

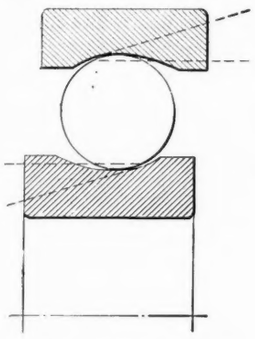
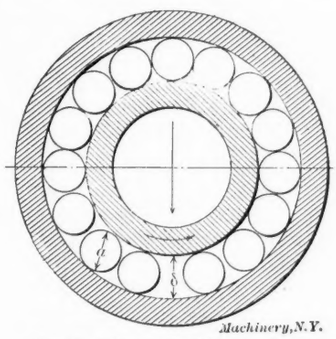


Fig. 9. Radial Bearing used as Thrust Bearing.

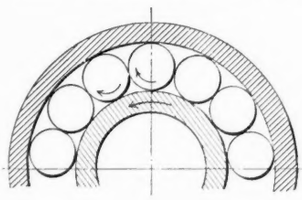


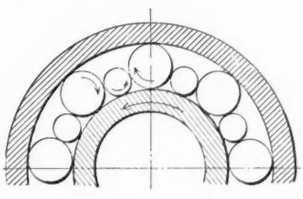
Machinery,N.Y.

Fig. 10. Diagram used in Analyzing Condition of Sliding Friction.

the balls to be more tightly pinched between the sound portions of the races, which will most likely cause overload. The rough surface of the groove previously worn will attack the balls, and in due time the entire race and bearing will be destroyed.

Theoretically, it would seem that a radial bearing would be incapable of carrying thrust load, owing to the wedging of the balls between the races. In Fig. 9, however, is shown the condition of a ball bearing where the ball does not entirely fill the space between the races if the bearing is not under load, and which, when under load, will assume the position shown. The ball does not come in contact with the race grooves where these are deepest, but so that the tangents to the race curvature at the contact points form angles with the line of thrust. A calculation of the amount of the wedging action in Fig. 9, with the radial freedom of ball permissible in these bearings, indicates an inadvisably large amount of wedging. Actual running tests, however, as well as a large fund of accumulated experience, have absolutely proved that these bearings will carry much more thrust load than the





Machinery,N.Y.

Fig. 11. Diagram showing Direction of Rotation of Balls, indicating Sliding Friction.

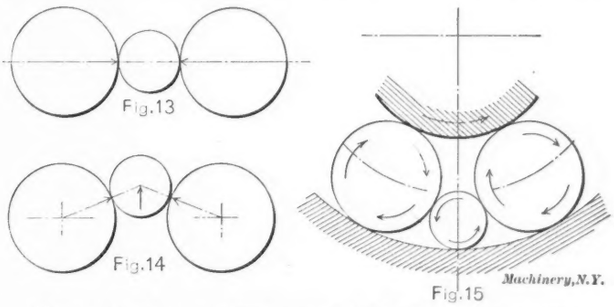
Fig. 12. Fallacious Means for avoiding Sliding Friction between Balls.

calculation of the theoretical wedge angle indicates as possible. It is probable that the deformation which occurs at the point of ball contact, which results in small surface *areas* of contact, instead of mere *points*, has a mean tangent to the compression surface of greater inclination, and that the wedge is therefore more blunt. It has been experimentally determined that the thrust carrying capacity of the uninterrupted type of annular bearings is to the radial capacity as 0.1 is to 1, and may be as great as 0.25 to 1, the variation depending upon the ball diameter, race curvature, and number of balls. It has been experimentally found that speed has but a slight influence on the thrust carrying capacity of this class of ball bearings, and for speeds above 1,500 revolutions per minute, these radial bearings are more efficient thrust carriers than the collar type.

The Supposed Sliding Friction in Ball Bearings.

Many designers have supposed that in ball bearings adjacent balls press against one another with considerable force. With the inner race in Fig. 11 running as indicated, the balls will also rotate as shown. The surfaces of the balls run in opposite directions, and therefore rub against one another. This is assumed to be a serious defect by those who reason that these surfaces are in contact under pressure. The same general cure in innumerable forms, as shown in Fig. 12, has been proposed time and again. This cure consists in the provision of smaller balls interposed between the larger ones, so that all the contacting surfaces roll in the same direction relative to one another. This remedy is, however, fallacious, in that it brings about the very condition it seeks to avoid. If two large balls, Fig. 13, compress a smaller one between them, and the three have their centers connected by a straight line, they will retain their relative positions, but if the interposed ball has its center to one side, as in Fig. 14, then this ball will be forced outward. The resort to a cage for retaining the interposed roller or ball results in the latter being pressed against the sides of the cage, and keeps the ball in forcible sliding contact, the very thing that it was intended to avoid. In another design, Fig. 15, the interposed member is brought into contact with the race, and while the various balls have a rolling contact in relation to one another, the interposed member has a wrong direction with reference to the race against which it is forced, and thus a sliding contact is produced. All these designs are based on a failure to recognize that axiom in mechanics according to which a force whose direction is normal to the supporting surface has no component in any other direction.

Analyze the conditions in a ball bearing, and, referring to Fig. 10, suppose that the shaft is loading the inner race, and that the latter is fallaciously assumed to act as a wedge, forc-



Figs. 13, 14 and 15. Analyzation of the Question of Sliding Friction.

ing the balls at the bottom apart and consequently producing pressure between the balls at the top. In that case the space δ must be smaller than the ball diameter a. The rotation of the inner race, however, will carry the balls around the bearing, and the diameter a is therefore forced through the smaller space δ. To do this the ball must lift the inner race. The force to do this is imparted by the load and is equal to the rolling friction, and can, therefore, amount to but a fraction of that load. We would then have the absurd condition of this smaller force overcoming the larger original force. Were we to assume that the inner race is not raised by a ball in passing, but that the ball is compressed sufficiently to get through, it would mean the absurdity that the small force represented by the rolling friction would be sufficient to deform the ball. The author concludes this portion of his paper by the remark that it may seem unnecessary to dwell so much on this fallacy of ball bearing design, but its surprising prevalence seems to justify the emphasis laid upon this phase of the subject.

[Having given space to the theoretical considerations in ball bearing design in this issue, a coming issue of MACHINERY will contain that portion of Mr. Hess's paper which deals with the practical side of the subject—the correct mounting of ball bearings.—EDITOR.]

* * *

It is stated in the *Brass World* that lead which contains a small quantity of tin and antimony does not corrode as readily as pure lead. When exposed to a damp atmosphere, the surface will not turn white as rapidly.

ERECTING MACHINERY FOUNDATIONS.*

J. A. PRATT.†

Machinery foundations are built usually of stone, stone and brick, and concrete. The principal characteristics of these materials are briefly as follows.

Stone is a very strong and durable material, and has great vibration-absorbing power but it is quite costly. Brick is not so durable as masonry, but it is cheaper and is everywhere available. In a brick foundation, stones are usually placed under the parts of the machine which rest on the foundation. Good bricks should have plane faces, parallel, sharp edges,

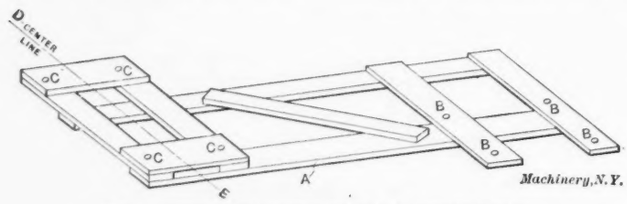


Fig. 1. Templet for locating Bolts for a Simple Engine.

and sharp angles; their texture should be compact, and free from holes. Concrete is a mixture of cement, sand, and broken stone, or gravel. Portland, Rosendale, and Black Diamond cements are used as the first ingredients; if Rosendale or Louisville (Black Diamond) cements are used in mixture, the foundation should not be put in use for two weeks after it is completed.

Method of Testing Cement.

Soundness and setting qualities of a cement are important, and tests of stock can be obtained from the mills. The following is a brief outline of the method of testing: Make four or five pats about 2 or 3 inches in diameter and about ½-inch thick at center, and thin at the edges. Put them on glass plates for the tests. The initial or first set is determined when this pat will bear a wire 1/12-inch diameter loaded with a ¼-pound weight. This should not take place in

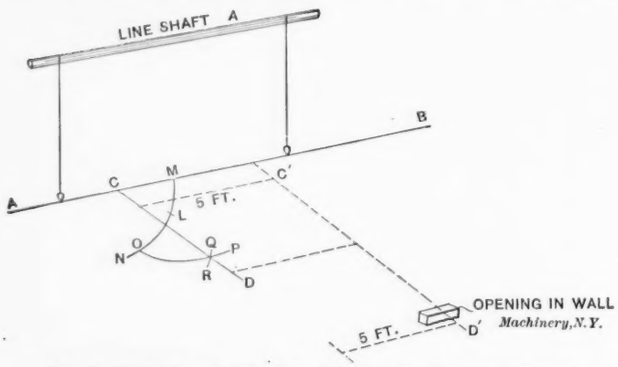


Fig. 2. Illustration of Method used for locating Reference Lines.

less than half an hour. The final set is determined when a pat will bear a wire 1/24-inch diameter loaded with a 1-pound weight, which it should do in less than eight hours.

Preparation of Lime Mortar.

Lime mortar is made by slaking lime entirely covered with water, to keep it from burning. Make of 1 part lime and 5 parts clean sand, and mix a day or so before using. If cement is used in the mortar, the cement should be thoroughly mixed with water and added just before using. Lime cement mortar is mixed as follows: One part cement, 3 parts lime, 5 parts sand.

Pure cement mortar is used a great deal at present and is mixed as follows: One part cement, 3 parts sand. Be sure to use this before initial set takes place.

Size of Broken Stone.

The broken stone, or gravel, should pass through a 2-inch screen and over a ¼-inch screen, and neither "tailings" or "fines" should be used in the concrete. It is best to avoid using limestones or stones of slate formation in foundation concrete. A typical mixture for concrete is 1 part cement, 3 parts sand, and 5 parts broken stone.

Mixing Concrete.

In mixing, the broken stone should be wet down before using; throw sand and cement on mixing board first, and mix well together in dry state; add sufficient water by sprinkling, so that water can be squeezed from a ball of the mixture in the hand. Do not mix ahead of needs, as cement concrete must be in place before initial set has taken place.

Preparing Foundation Pit.

Let the foundation pit be deep enough to go below the frost line of the locality. On the bottom of this pit prepare the foundation bed, by first going over the whole bottom of the pit with rammers, and thus tamping it down. Place on this surface good sized stones about a foot apart, and fill the

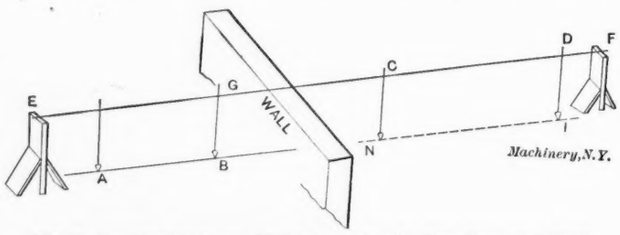


Fig. 3. Locating Reference Line by carrying the Line through a Wall.

spaces between these with concrete of the mixture given above. This bed may be from 1 foot to 18 inches thick.

Construction of Templet.

The next step is the making of the templet by which all the holding-down bolts are correctly located. This templet should be solidly built of good pine boards about 1 inch thick, and, say, 1 foot wide. Lay out accurately on it all bolt holes and all center lines.

Fig. 1 shows a templet for a simple engine. The edge of the board shown at *A* should be planed straight, as it is used as the main center line of the engine. From this edge or center line are located all other center lines on the templet. From the foundation drawing lay out the main shaft center line *D*, *E*, perpendicular to edge *A*. Next lay out the centers of all holes from these two lines, taking dimensions from the drawing. Bore holes about 1 inch larger in diameter

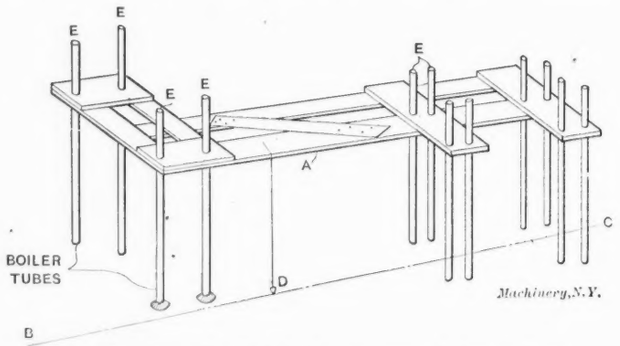


Fig. 4. Leveling and setting the Templet true to Reference Lines.

than the foundation bolts. These large holes will permit the use of pipes as centers for the holes when building the foundation.

Locating Reference Lines.

The next step is the getting of reference lines from the center line of the shaft to which the engine is to be connected by belting or gearing. Figures 2, 3 and 4 will give some idea of the methods used in such layouts. Fig. 2 shows at *A* what we assume to be the old line-shaft, over which we drop two plumb-bobs. Hang these so they will be about 1 inch from the floor, and when they are perfectly steady, let them drop, making a slight dent on the floor. Make this mark as deep as required by the use of a scratch-awl. Then stretch a chalked line, and snap a line on the floor, passing through these points. We now have a line parallel to the line-shaft to which we must connect. If some present installation of machinery is in the way on the floor, transfer this

* See also MACHINERY, January, 1903, engineering edition: Shop Construction—4, Foundations; August, 1903, engineering edition: Concrete Foundations; and March, 1907: Foundations for Machine Tools.

† Address: Pratt Institute, Brooklyn, N. Y.

line to the ceiling overhead, where it will serve the purpose just as well.

Since the engine center line will usually be perpendicular to the shaft line, we must establish a perpendicular to this line, and the method of doing it is shown in Fig. 2. Select the point from which the perpendicular is to be drawn, which, of course, will be taken at the position where the engine must finally line up. This point *C* is taken as a center, and with any radius—the longer the better—swing arc *M N*.

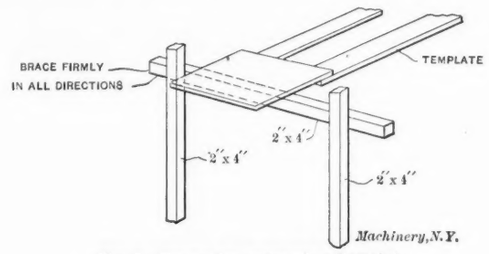


Fig. 5. Frame for supporting Templet.

Next take *M* as a center and swing short arc *L*, intersecting *M N*. Now from *L* as a center swing arc *O P*. Take *O* as a center and swing arc *Q R*. The point of intersection of *O P* and *Q R*, and the selected point *C* on the given center line, will determine the required perpendicular. Notice that the radius for striking the various arcs is not changed from the start to the completion of the operation. Trammels should be used when describing these arcs. The line *C D* may be extended indefinitely, so the engine can be located at such distance from the shaft line as conditions of belting or gearing require.

A machine to be installed, possibly, may be in another room with a partition between the engine shaft and the shaft to be driven. In this case we have to carry the line through the partition. Fig. 3 shows the method followed in getting the lines located. Two stiff wooden uprights are erected at any selected distance from the wall in question, and the line is stretched tightly between them.

Assume that line *A B* is the portion we have placed on the floor, while the dotted portion shown on the farther side of the wall is the portion we desire to locate. Set the two uprights or targets *E* and *F*, and stretch the line. Adjust the line by letting two plumb-bobs hang so they touch the line struck on the floor. Bring the target line *E F* so it will just touch the plumb-bob strings. Now the portion of the target line, *E G*, is exactly over the perpendicular, which was located as described in Fig. 2. The portion of the target line *G F* now becomes an extension of *E G*, and by dropping plumb-bobs as shown at *C D*, so they just touch this line, we may locate a second section of line, either parallel to *A B* or in direct continuation of it on the farther side of a wall.

This line may be struck on the ceiling as well as on the floor if obstructions are in the way. It is usually extended through a convenient window, which may or may not be in

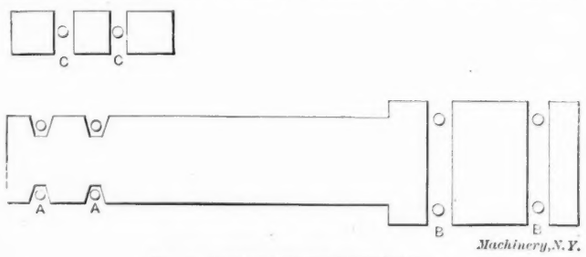


Fig. 6. Laying Out the Foundation.

direct line with *C D*, Fig. 2. In such a case, we measure off in perpendiculars from the first line such a distance as the opening through which we wish to pass the line may require (in this case 5 feet), and after passing the line through the wall, measure back again. This work is indicated in dotted lines, Fig. 2. All perpendiculars are struck as directed in connection with *C D*, Fig. 2, using trammel points and large radii.

Locating the Templet.

The templet should be slung from the roof timbers if they are in place, and, if not, a good stiff framework of 2 x 4's should be put up. A portion of such a frame is shown in Fig. 5. There should be one at each end of the foundation, and they should permit the templet being slung high enough to complete all work without cramping the masons for room.

In concrete work it is not always necessary to keep the templet in place till the foundation is up to full height, as the setting of lower layers of cement will hold any centers for bolt holes firmly in place, and there is no necessity for a support at the top.

After the templet is hung, it must be carefully leveled up, and the edge *A*, Fig. 4, set perfectly true with the line *B C* which we placed on the floor of the pit. To do this, drop plumb-bobs over the edge *A*, and move the templet until they are true with *B C*. Now nail the templet firmly to the framework. Next cut some pieces of boiler tube long enough to reach from the foundation bed to 6 inches above the templet, and of same diameter as the holes bored in the templet. Slip these tubes through the holes and set them plumb. As each tube is set, build a little wall of cement around the lower end to keep it in place. See tubes at *E*, etc., in Fig. 4.

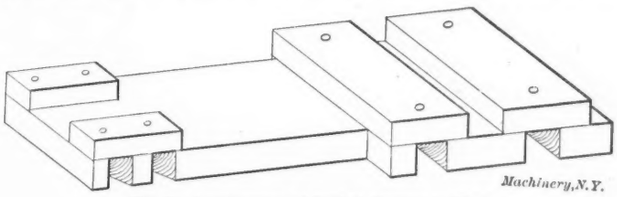


Fig 7. Appearance of Pocket Covers in Place.

The foundation should be larger at the top than the base of the machine for which it is built. The "batter," or inclination of the sides from the vertical, should be from 1½ to 3 inches per foot. See Fig. 8.

Locating the Bolt-head Pockets.

Now lay out the form of the foundation on the base as shown in Fig. 6. The various pockets are shown at *A*, *B* and *C*. These pockets usually should be placed in a foundation for convenience in tightening up the bolts. In small work, however, the bolts are often set in the templet (instead of using tubes and masonry built around them) leaving them solid in foundation. In such cases pockets are not needed. Pockets should be high enough to permit the bolts being dropped below the upper surface of the foundation while placing the machine. The pockets should be covered with

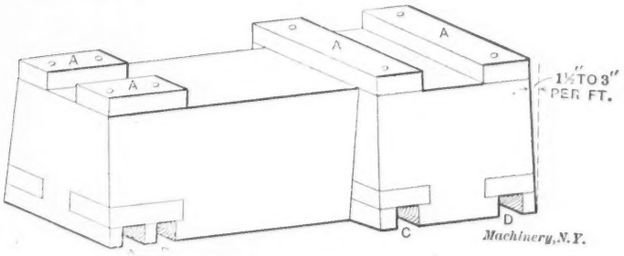


Fig. 8. Foundation with Cap Stones in Place.

a stone or iron slab as indicated in Fig. 7. In placing these stones, slide the boiler tubes up through the templet and set the covers so the tubes can be freely turned when held by the templet and cement guide on foundation bed.

Leveling Cap Stones.

The feet of the machine should rest on stone slabs about 8 inches thick. All brick or stone used should be wet down before placing, unless the weather is freezing, in which case mortar may be mixed with hot water and the work protected with boards at night.

Fig. 8 shows a foundation with the cap stones in place. Be very careful that all cap stones are set level, and all in the same plane or parallel planes.

Fig. 9 shows the method of leveling stones with each other by use of a pair of cast iron cubes, straight-edge and spirit level. Level the stone which is placed at the highest part of the foundation first. After setting the cap stones, the foundation is complete. Then transfer the center line from the foundation base to its top face, and it is ready for the machine.

Advantages of Concrete for Foundations and Method of Construction.

Concrete makes an ideal foundation material, since, when it is set it becomes practically one solid piece. The method of construction is much different from putting up a masonry foundation, and much less expensive. The bed is prepared and the templet is carefully set to center line as described before. All concrete work is molded in forms. The timber for these forms should be about 1 inch thick, dressed on one side for the purpose of getting a smooth surface on the work, and braced about every 2½ feet. Fig. 10 shows a foundation form set up and braced for filling. Two methods of external bracing are shown. At *A* the braces are carried horizontally to the side of the excavation; at *B* a piece of timber is firmly set in the ground, outside the base, and all bracing brought to it. The inside of the form should be braced about every foot in height; the upper brace of one of these sections is shown at *C*. Such braces are placed inside for the entire height of the foundation, spaced as just mentioned. As the concrete is put in place the braces are removed.

The form should be carefully placed to the layout of the foundation, and pocket molds set. Fig. 11 shows a pocket mold

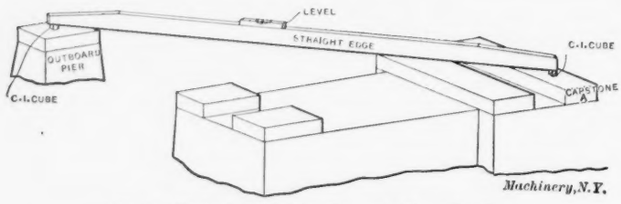


Fig. 9. Method of leveling Stones with each other.

and Fig. 12 a top view of the form set ready for filling. The pocket molds are simply wooden boxes of the same outside dimensions as the pocket is required inside, and finished smooth. These molds should be soaked in water 2 or 3 hours before using to prevent their swelling and sticking in the concrete. They may be nailed to the main mold, or wires may be fixed to them, which pass through the main mold, and tightened by means of wedges in a manner similar to that used by a molder in holding suspended cores. These pockets must be firmly fixed in place.

The next step is filling the form. Do not use concrete that has stood mixed much over 20 minutes. Ram with rammers weighing about 1 pound per square inch of face area, and ram until water just shows at the surface. Put down in layers about 6 inches thick, and work down next to forms with a shovel to get a smooth surface. The foundation may be filled with good sized stones, about the size of a man's head, about 1 foot apart and at no place less than 1 foot from foundation surfaces. Wet these stones before laying. If the work is

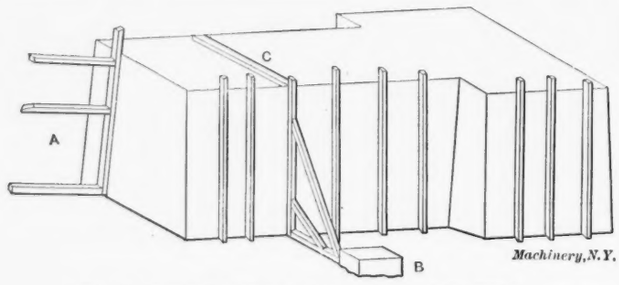


Fig. 10. Foundation Form set up and braced for Filling.

stopped at night, make grooves in the surface, and when starting next morning sprinkle and dust over with dry cement.

As soon as the cement has set, strip off the forms, as it is much easier to patch when cement is somewhat green.

Foundation work is sometimes "slushed" instead of being rammed. In this case, the concrete is mixed just wet enough so it cannot be piled up. The concrete is then dumped into molds, and worked in them to prevent air bubbles. The first method gives a more homogeneous structure, as there is no chance for the broken stone to settle. Turn the pipes occasionally as the foundation goes up, to prevent their becoming set, if they are to be removed. Sometimes they are left in the foundation as a sort of lining to the foundation bolt holes. When the machine is set approximately true, the space around

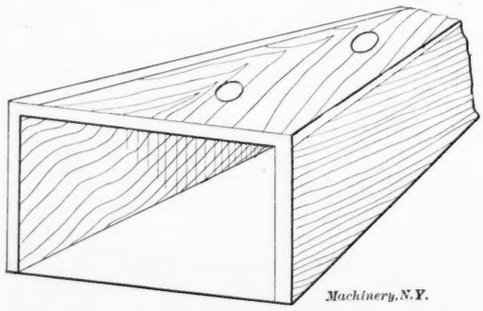


Fig. 11. Pocket Mold.

the foundation bolts may be filled with liquid cement, lead, or melted sulphur.

* * *

An Austrian journal, *Technische Neuerungen*, has published some computations, taken, it states, from an English source, which give an idea about the cost of our inventive age. Not counting trade-marks, copyrights or registration of labels, there have been 3,500,000 applications for patents since the patent system was inaugurated, and about 2,500,000 of the applicants have been granted letters of patent, the United States having granted almost one-half of these, or about 1,000,000. The government fees for this alone have amounted to about $180,000,000. This, however, is only small part of the expense incurred for patents. Solicitor's fees and the expense incidental to maintaining the granted patents may be estimated to at least $1,100,000,000. A conservative estimate places the total cost of litigation for protecting patents to $1,700,000,000, and the promoters' rake-off to $1,200,000,000.

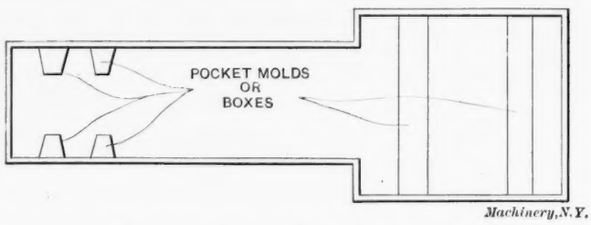


Fig. 12. Top View of Form ready for Filling.

The total cost of development has been estimated at more than $6,000,000,000, so that the grand total of all these various items, all incidental to patenting and exploiting patents, is about $10,200,000,000, and with a reasonable interest for an average of thirty years, the total cost to the world for its patented inventions should be placed at about $30,000,000,000. Now, the main question is if individual inventors, for the protection of whom we must consider that many of these charges have been paid, actually were benefited to any amount in the least proportionate to the stupendous sums expended.

* * *

The Northern Pacific Railway Co. has recently built a novel roundhouse at Dilworth, Minn. This roundhouse contains 44 stalls, having pits so arranged that the ashes from the engines can be dumped into them, thus avoiding the delay which is often caused by sending the engines to an outside ash pit. There is a depression in each roundhouse pit, which contains perforated pans for receiving the ashes. These pans, which are about 72 by 30 inches, are submerged in water for the purpose of cooling the ashes. There are two pans in each pit so that two engines can use the pit before the ashes need to be removed. The pans, when filled, are lifted by an electric hoist which travels on an overhead track, and carried to a cinder shed where the ashes are dumped from the pans into cars. This arrangement will make it possible to clean and bank the fire without delay, which will mean a saving in coal, and a reduction of the terminal expenses.

NEW SHOP OF J. E. SNYDER & SON.

H. P. FAIRFIELD.*

Since 1892, and up to recent date, the shop of J. E. Snyder & Son was located in a large power building on Beacon St., Worcester, Mass. Owing to a steady increase of business, which made the old quarters too small, and because of a wish for more convenient and better lighted shop conditions, the company has built and moved into the building shown by the accompanying photographs. The new shop is located at the intersection of Parker and Dewey Sts., convenient to car lines running to all parts of the city and to the union station.

In selecting this location, attention was paid to the needs of the workmen, and the reader will note that the shop is surrounded by residences, making it an easy matter for the workmen to secure a home within an easy walking distance of his employment. This is a feature too little thought of by some firms when choosing a site for a new works. The construction is of concrete blocks, giving a building which is not only substantial for its purposes, but pleasing in appearance, an essential point when it is remembered that the location is residential. Special attention was paid to uniform lighting, and Figs. 1 and 2 demonstrate the means employed, the walls consisting largely of windows, and the central area of the roof of glass monitors.

The views showing interiors also show the method of lighting. There are four bays from north to south, those on either side receiving light from the wall windows, while the two central ones are lighted by the roof monitors.

The shop is so well lighted, that when taking the interior photographs shown, no difference in the time of exposure was found necessary, and the writer has never before found this to be true.

Fig. 3 is a view taken near the shipping door at the north end of the building, and shows the erecting bay with a portion of the shipping floor. The offices and drafting rooms are located at the right of this view.

Fig. 4 is taken from the north end near the offices, and shows the gear cutters, milling machines, and lighter lathes, and looks out toward the setting-up floor.

Fig. 1. View from the North.

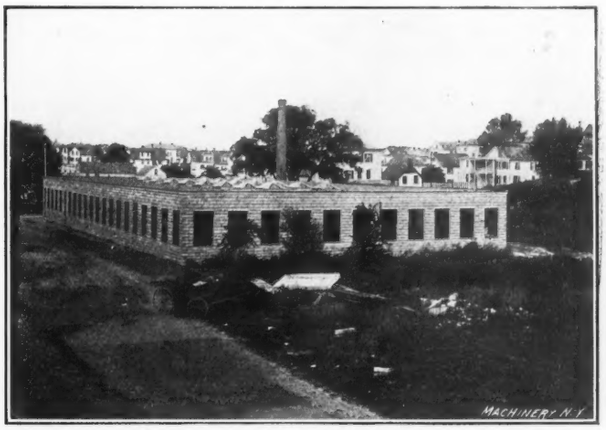


Fig. 2. View from the South.

Fig. 3. Shipping Floor and Erecting Department.

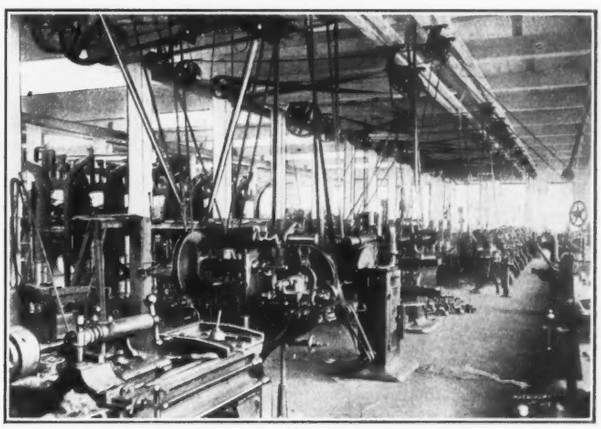


Fig. 4. Gear Cutting and Small Lathe Work.

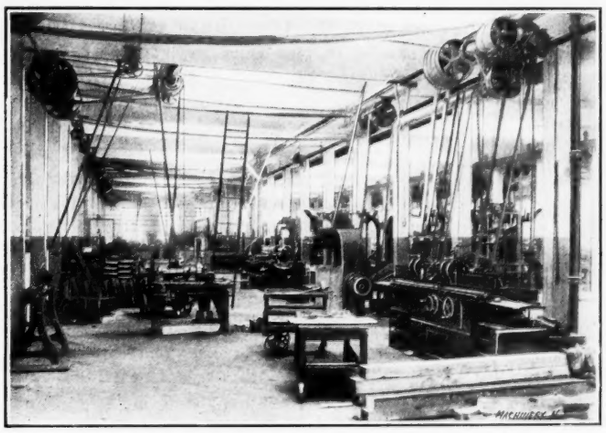


Fig. 5. Grinding, Boring and Heavy Turning, also Tool-room in Middle Distance.

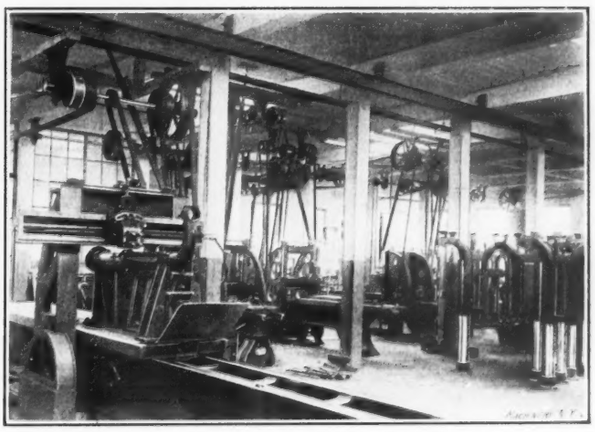


Fig. 6. Planers as seen from Erecting Floor.

* Address: Worcester Polytechnic Institute, Worcester, Mass.

In Fig. 5 is shown the grinding, boring, and heavy turning machines, and in the middle distance the wire netting surrounding the tool room can be seen. A view of the planers from the setting-up floor is shown in Fig. 6.

About 1882, Mr. J. E. Snyder first began to manufacture, in a small way, the drilling machines for which he has since become so well known. Then the firm name was Currier & Snyder, and the shop was located on Central St. In 1884, the firm removed to Hermon St., and in 1892 to Beacon St. Mr. Snyder bought out Mr. Currier's interests in 1894, and his son entering the business with him in 1902, the present firm name of J. E. Snyder & Son was adopted.

Like many machine tool builders, they have deemed it best to concentrate their efforts in manufacturing a single, straight line of machines, namely, drilling machines in all sizes from small lever machines to those of the largest back-geared drive and geared feed machines. These are built in lots of forty, sixty, eighty and one hundred, according to size. Their products go to all parts of the world, and foreign orders are now booked for months ahead. At the present writing the company has about sixty machinists in its employ, having very recently moved into its new quarters.

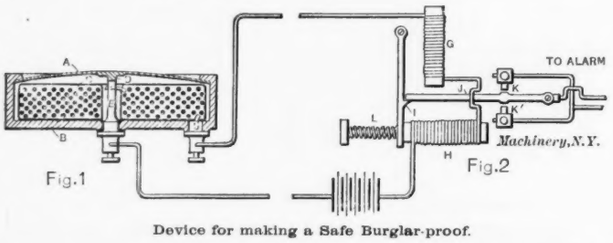
* * *

THE BURGLAR AND THE SAFE MAKER.

GEORGE P. PEARCE.*

The fight between the burglar and the safe maker is very similar to the fight between the armor plate manufacturer and the gun builder. First one is ahead, and then the other. The only difference is that the safe maker has never been far enough ahead to make himself prominent. The burglar is very enterprising in his bad way, for he was among the first to use the electric current for burning holes in a plate. He took advantage of "Thermit," and now, according to October MACHINERY, he is getting quite handy with the oxy-acetylene blow pipe. Any attempt to discourage him with ethyldichloracetate fumes, or other noxious or dangerous vapors, as suggested, would surely be a failure, for a modern safety helmet would enable him to attend to his business without much inconvenience. The following is a description of an attachment for protecting safes, which in my opinion would possibly check successful attempts at burglarizing for some time at any rate.

Let an electric contact device be made along the lines suggested in Fig. 1. The top plate *A* being a sheet of thin springy brass, and the frame *B* a casting. The coil *C* is a resistance, the contacts *D* and *E* are of platinum, and the connections are as shown. In assembling, the plate *A* should be slightly sprung out, as shown, so as to cause a good contact between *D* and *E*, and then the whole box hermetically sealed. This device would be suspended inside the safe, the



Device for making a Safe Burglar-proof.

wires brought out through air-tight joints and connected to the alarm, shown diagrammatically in Fig. 2, which could be placed in any desired location. In operation, the safe would be closed as usual, and the current switched on. This would cause a large current to flow through the contacts *D* and *E*, and the electro-magnets *G* and *H*. This current would cause *G* to attract *J*, closing contact *K* and thus throwing in circuit the auxiliary current and ringing the alarm. Next it would be necessary to obtain a partial vacuum in the safe by means of a small pump. This would cause the air confined in the contact device to push the spring surface *A* outward, thus breaking the contact between *D* and *E*. The current will still be able to flow through the resistance coil *C*, but it will be greatly weakened, and the electro-magnet *G* will not be powerful enough to hold *J*, which will fall and catch on step *I*. Magnet *H* will still be magnetized enough to just overcome the tension of the spring *L* and thus keep *I* in position; thus contact at *K* will be broken, and the alarm will cease to sound. The partial vacuum will also cause the door to be tightly drawn against the rubber packing and thus prevent leakage.

Now as soon as a burglar makes a hole in the safe, the air will rush in, and spring plate *A* will return to its first position and close the short circuit. The extra current will magnetize *G* to a greater extent and cause it to pick up *J*, closing its contact with *K*, and operating the alarm. Should the burglar cut the wires, the magnet *H* would lose its magnetism, and *I* would be drawn back by the spring *L*, allowing *J* to fall and make contact with *K'*, thus again operating the alarm. A resistance could not be inserted between the line wires to balance the resistance coil *C* while the wires were cut, because the resistance of *C* would be unknown. If the new resistance was too great, or too small, it would either cause the magnet *G* to lift *J* and ring alarm through the contact *K*, or it would decrease the power of magnet *H*, which could not then overbalance the spring *L*, which would pull *I* back and let *J* fall and close the contact *K'*, and again ring the alarm. Any attempt at testing the wires would also disturb the balance in the alarm box and cause the signal to be given, and thus it would certainly be a difficult matter to get the valuables without sounding the alarm.

* Address: 384 Prospect Ave., Buffalo, N. Y.

* * *

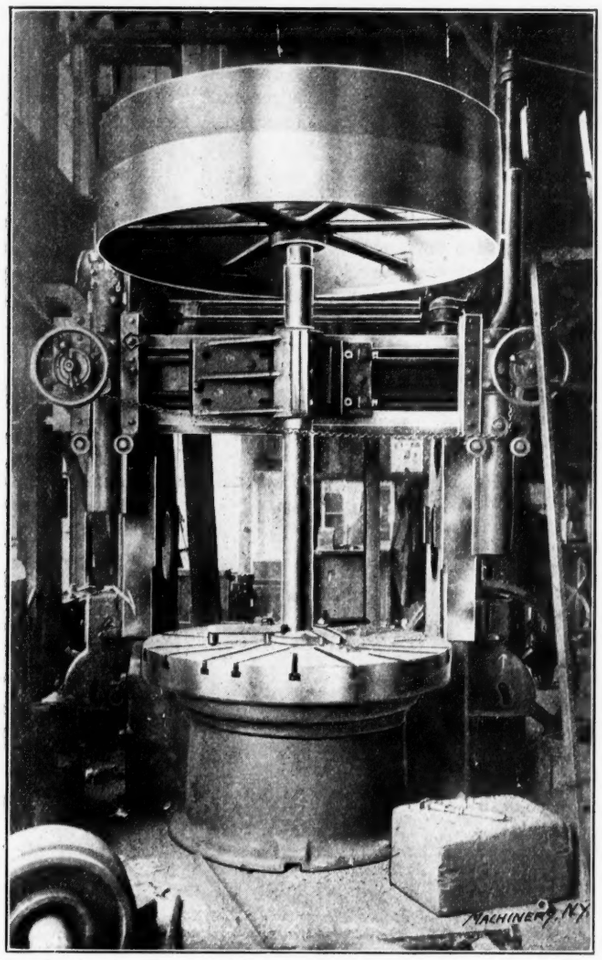
TURNING A 76-INCH PULLEY ON A 60-INCH BORING MILL.

R. C. PORTER.*

The accompanying half-tone shows the manner in which a 76-inch pulley was successfully finished at the shops of the California Iron Works Co., Eureka, Cal. The shops in question are not equipped with lathes or other turning machinery to finish work of a larger diameter than 60 inches, as the ordinary run of work in this shop does not call for machinery of larger sizes. A case came up, however, in which a pulley 76 inches in diameter and 21 inches wide was required to be turned. After some meditation, it was concluded that by rigging a 60-inch Colburn boring mill as shown in the cut and as described below, it was possible to finish the pulley on this machine. In the first place, the casting shed was searched for some old 6-inch post boxes, which were then planed on the back and bolted to the cross rail of the boring mill. In order to enable these boxes to be used for the same kind of work in future jobs, dowel pins were also provided, so that the boxes could be located in exactly the same position if wanted for use again. These boxes were, of course, not as yet babbitted. A piece of 6-inch shafting was now turned on one end to fit the hole of the pulley, which had previously been finished to size in a radial drill press, and key seated. The other end of the shafting was turned to fit the center hole in the face-plate or table of the boring mill. The length of the shafting, of course, had to be made such that when the pulley was placed on its upper end, and the lower end fitted into the table, the shaft would reach fully through the hub of the pulley, so as to give a satisfactory bearing. An extra heavy piece of pipe flange was then keyed to the lower end, and faced true with the shaft, after which the arbor was erected on the mill, the flange bolted to the table, and the shaft located in the center by means of placing the end to fit the center hole in place in the table. The machine was then started, and the arbor was trued up until it was running perfectly correct for its whole length. The boxes bolted to the cross-rail were then babbitted, so as to give an upper bearing to the shaft. As in this case it was necessary to feed the tools upward instead of down, the tool-holder heads were detached from the machine and reversed, the left-hand head being put on the right-hand side and *vice versa*. The pulley was then hoisted in place by a crane, and was keyed firmly to the upper end of the arbor. Tool-holding bars were now placed in the heads, one on each side of the pulley, one taking a roughing and the other a finishing cut. On account of the width of the pulley it was not possible to finish the whole face at one setting, and, therefore, when one-half of the pulley was turned, it was reversed and the other half

* Address: California Iron Works Co., Eureka, Cal.

finished. The face was crowned the same as any ordinary pulley. Novo steel was used in the tool-holding bars or cutting tools, and a feed of 0.043 inch, and a ¼-inch depth of cut for the roughing cut was used. In order to prevent the chips from falling down into the tool-holder heads and injuring



View showing the Way in which the Pulley was attached to the Boring Mill.

the ways, burlap was thrown over the heads and the guides. This arrangement worked very satisfactorily, so much so, in fact, that it was concluded to finish two 96-inch diameter by 10-inch face band mill-wheels in the same manner.

* * *

AN OLD-TIME APPRENTICESHIP.

BACK-NUMBER APPRENTICE.

The apprentice who starts in nowadays to learn the greatest of all trades (though by no means the best paid), the machinists' trade, has a much easier time in a great many respects, than he would have had fifteen or twenty years ago. Now he works so many weeks, or months, on various machines, and so many more at the bench, or on the floor, and passes through a regular course, often having a special foreman to look after him, and see that he learns all that he should in each branch.

They used to start us snagging castings, cutting bolts, and sweeping up the shop. Happy were we, when the boss came around and told us to help some one do a little repair job over in the mill, or out in the yard somewhere. The erecting floor, so called, was a space between the drill-press and the wood planer, in the "wood butcher's" end of the shop, and directly in the passage to the blacksmith shop and the pattern shop. Here were brought pumps, engines, water-wheels, or anything else that couldn't be repaired where it stood, and the apprentices, sometimes assisted by some superannuated pensioner, would scrape off the accumulations of grease and dirt, while some of the handy-men, who did anything, and everything, would take it apart and stack up the pieces in some out of the way corner, until they were needed. Here the "cubs" reveled in dirt, hoping that they might get a chance to bore out a bushing, or plane up a pillow-block cap, or do any other little job that called for a "pretty fine fit," or a "light drive," as the case might be. One man in the shop had worked "down country," and was used to seeing men who used micrometers every day, but to us, they were a useless extravagance, and if anybody had attempted to use one, he would have been considered as putting on airs. How we did look up to a man who could take his calipers over to the mill and caliper a shaft, and then come back and bore out a gear to fit "just right," without any worry or fussing. We would stand beside his lathe, when the boss was out, and watch the boring tool chattering its way through the pulley, or gear, while he leaned carelessly against the ways, and explained that *he* always set his inside calipers just a "feel" to his outside calipers, and of course couldn't make a mistake.

I recall an experience of my own which may be of interest. I was told to turn the bolts for a flange coupling, and make them a light driving fit, and, of course, I wanted to make a record, so I rushed the job along until the bolts became heated. They were finished, and driven into the coupling while in this condition, and after a while the boss came around to inspect the job. In the meantime the bolts had become cool, and the boss was able to drive them out with his hand. I learned more about the expansion and contraction of metals from this simple experience, than a year's study of physics would have taught me.

The variety of work that we had was not as great as it is in a job shop, but it was varied enough to keep it from being monotonous. Once there was some difficulty with one of the Westinghouse single-acting vertical engines, which made it necessary to send an expert up from Pittsburg to investigate. The engine had to be rigged up so that indicator cards might be taken, and I had the pleasure of helping on the job. The expert, a gray-bearded, white-haired old man, seemed to me to be the smartest man I had ever seen. He would take a card, and then taking it off the drum, would study the, to-me-meaningless curve, and nod his head wisely, and mutter something about the valves or eccentric. At any rate, he located the trouble, and repaired it, or had us do it, and sent in a nice little bill, I suppose. It was whispered around that he got five dollars a day, and expenses, for his services, which looked mighty big to an apprentice getting seventy-five cents a day, and paying his own expenses at that.

My experience after going into a railroad shop was somewhat different. Not having served my time, I was considered an apprentice still, and as the other apprentices didn't know that I had had any shop work at all, I was the object of many remarks, when the boss put me on a bolt lathe. When I passed over several others and got this job, there was a good deal of feeling, which gradually disappeared when they found that I could turn bolts to fit, without filing off the last 1/64 inch, as seemed to be the custom. Sometimes I was given a planer job, which was rated as a "snap," because I could sit and watch the machine run, and no one came along and told me to take a heavier cut. Work on the pits was harder and more disagreeable, but the apprentices all got their share of it. That branch of the work was managed a little better as regards supervision, as each pit was in charge of a gang boss, and there was considerable rivalry between them, to see who could turn out the most engines; so they would show the apprentices the best way to do things.

Things are much better in connection with railroad work now, and railroad shops are rapidly being put on a commercial basis; and it is to be hoped that some adjustment of the apprenticeship problem will be reached, which will put railroad apprentices on a footing approaching that in the best manufacturing shops.

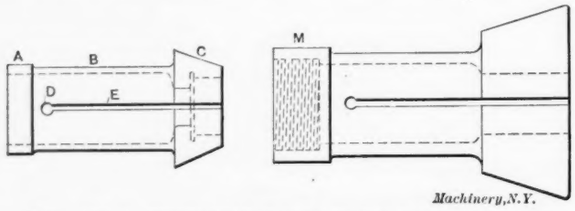
* * *

Do not lose heart and get discouraged. Your success does not lie in the hands of others, but in your own. Do not think that the world is down on you or that, because you merely work hard, you should succeed. The man who works hard building ice ponds in Florida or planting orange groves in Maine is not entitled to victory.—*William F. Forbes, in Stevens Institute Indicator.*

LETTERS UPON PRACTICAL SUBJECTS.

MAKING SPRING COLLETS.

Spring collets are now used in nearly all shops, and there are many varieties, depending on the work they are required to hold, and the machine in which they are used. I will describe how three kinds that are used at our shop are made. The one illustrated in Fig. 1 is the smallest, and this collet is used on a small nut machine, while drilling, facing and tapping small solid cast brass nuts. This collet is closed on the work by being thrust forward into a taper collar. The



Figs. 1 and 2. Showing Collets of the Push-in and Draw-in Types.

collet is made heavier at *A*, because the plunger strikes it there, and also because it will keep its shape better while being tempered or case-hardened. The collet has three slots, 1/16 inch wide, which allow quite a little spring. These collets are now made of machine steel. They were formerly made of tool steel, but it was found that by using machine steel the original cost was much less, and the wearing qualities were very much better. Tool steel crystallizes from constant springing, and owing to their shape, the collets were frequently broken in tempering.

To make the collet, a piece of machine steel just a trifle larger than the finished collet is chucked, and the end *A* faced. The smallest size hole of the collet is bored clear through, and the large hole is bored as deep as the head *C*. The piece is then put on a mandrel, which only fits into the

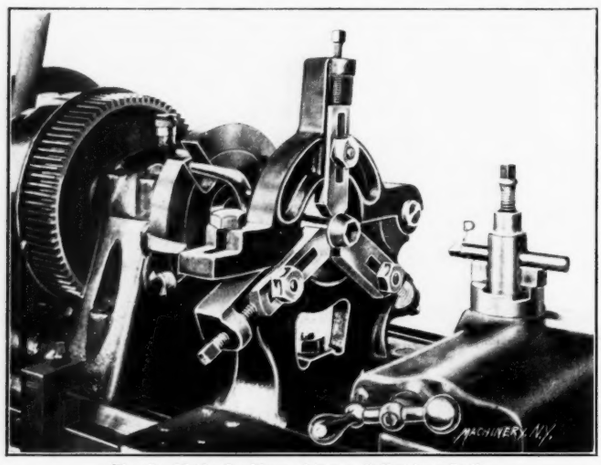


Fig. 3. Method of broaching a Collet in a Lathe.

collet as far as the head *C*, and the other end is faced. The parts *A* and *B* are turned, and then the compound rest is set, and the head *C* is turned to the required taper. The steady-rest is now placed on the lathe, and adjusted to the work just back of the head *C*, as shown in Fig. 3. A hole is then bored, the diameter of which is equal to the short diameter of the hexagon nut which the collet is to hold, and the depth about 3/64 inch less than the length of the nut. At the bottom of this hole a narrow recess is cut. The diameter of this recess should be a little more than the distance across the corners of the nut to allow the broaching tool to cut through. The broaching is done in the lathe, and when this is being done, it will be necessary to rotate the lathe through one-sixth of a revolution, as a hexagon is to be formed. This can be done by laying off six equal spaces on the face-plate, and measuring with a pointer from some fixed point on the bed to the spaces; but if the number of teeth on the large gear is right, this will not be necessary. For example, the gear shown in Fig. 3 has seventy-eight teeth. These are divided into six equal divisions, or every thirteenth tooth is marked A steel stop, which rests on the bed of the lathe, is made to engage with these marked teeth, and in this way the necessary divisions are obtained. The broaching tool is shown at *D*. The broaching is done by moving the carriage back and forth by hand. Several cuts are taken, then the work is rotated through one-sixth of a revolution, and the operation is repeated. This is continued until the hexagon is nearly to the required size. The tool is then set to make the hexagon the finish size, and the six cuts taken without moving the tool. The back gear should be in when doing this work, in order to steady the spindle. We formerly laid out these hexagons, and cut them in the shaper, but it is very much better to broach them, using the lathe. After the hole is broached out, three ⅛-inch holes *D* (see Fig. 1) are drilled. These holes are spaced so as to be in line with every other corner of the hexagon. The collet is now driven on a man-

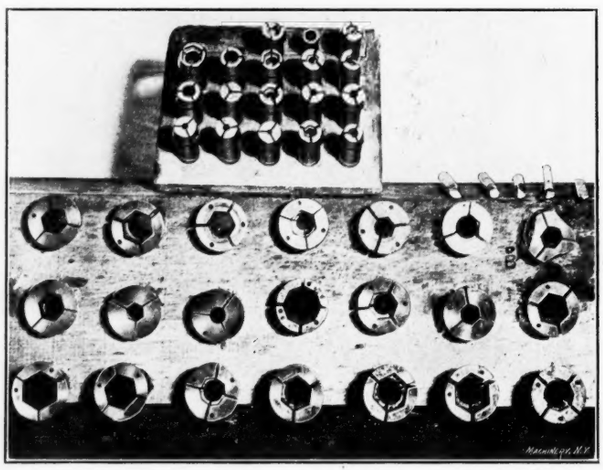


Fig. 4. Collets of Various Sizes and Broaching Tools used in making them.

drel, and the slots *E* cut. This is done on the milling machine, a 1/16-inch slitting saw being used. After the collet is slotted, the burrs are filed off, and it is ready to be case-hardened. Pieces are then inserted in the slots to spread them open, and they are case-hardened while in this position, which permits the work to be inserted easily.

The collet shown in Fig. 2 has an internal thread at *M*, and it is screwed onto the plunger or quill. This collet is closed by being pulled into a taper collar. It is used for holding round and hexagon bars, brass fittings, etc. This collet has three holes drilled into its face, and a wrench having three pins which fit into these holes, is used when screwing the collet onto the quill.

The collet shown in Fig. 5 also has an internal thread, and it is much heavier than the other two. It has four ⅛-inch slots, which allow it to spring, and there are four grooves cut into it, which engage with keys, making a positive

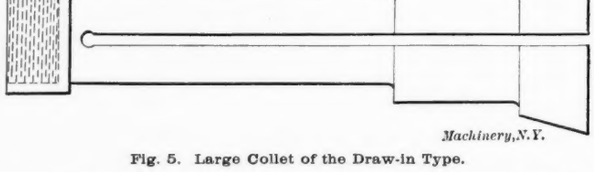


Fig. 5. Large Collet of the Draw-in Type.

drive. The collet is opened and closed by compressed air, and it is used for holding compression cock stems, and similar pieces, while they are being box-tooled and chased with a die. An 8-pitch, square thread is cut on the stems referred to, which shows how well this collet holds the work. That part of the collet which comes into contact with the work, is corrugated to prevent the work from slipping. These corrugations are also made by broaching.

A number of these collets are shown in Fig. 4. The small

collets shown at the top are the same style as the one illustrated in Fig. 1, and the larger ones below, are the same as the one shown in Fig. 2. The collet marked *B*, which is seen in the upper right-hand corner, illustrates the way in which they are sometimes broken in tempering. The tools shown just above this broken collet are the broaching tools. Two of these are used for cutting hexagons, one for squares, and the other two for corrugating the collets.

Decatur, Ill. J. J. VOELCKER.

TOOLS FOR BORING AND TURNING SPACING COLLARS.

The tools shown in the accompanying illustrations are used for the boring, reaming, and turning spacing collars. By using these tools the collars can be bored, reamed, and faced, while in the chuck, which is a decided improvement over the method formerly employed. This method consisted of first boring and reaming the collars in a chuck, and then driving them on a mandrel to be faced. As a rule the width of spacing collars must be within a certain limit, as they are used in strings of from thirty to sixty on one shaft, and any variation in width will be multiplied according to the number used.

When using the tools shown, these collars can be bored, reamed, and faced in a turret lathe. Fig. 1 shows the combination drill, boring tool, and reamer used. Three high-speed steel cutters *A* in the shape of a Woodruff key, are set into the soft steel shank *B*, forming a three-lipped drill. The boring tool *C*, which follows the drill, trues up the hole and makes it the proper size for reaming. The reamer *D* is of the "floating" type, and it is kept from turning by the projections on the sleeve *E*. This sleeve, which is split, fits into a socket, and acts as a holder for the drill and reamer. With this arrangement, it is not necessary to swing the turret-head around, as would be the case if three separate tools were used. The only requirement is that the speed be changed when using the different tools. After a collar has been bored and reamed, it is faced to the required width by using the straddle-tool shown in Fig. 2. The shank *F* of this tool fits into the cross-slide of the turret. The cutters *G* fit into a slot as shown, and the distance between their cutting edges is regulated by the adjusting wedge *H*. The wedge and the cutters are each held by a separate set-screw, to allow independent adjustment. After they are properly set, they are fastened securely in place by the set-screw *I*. A side clearance of 3 degrees, and a back clearance of 5 degrees, is given to each cutter. That part of the shank containing the cutters is made oval, as shown in the end elevation, Fig. 2, so that the tools can have sufficient lateral movement for facing the work.

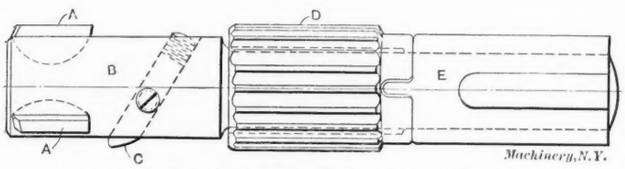


Fig. 1. Combination Drill, Boring Tool and Reamer.

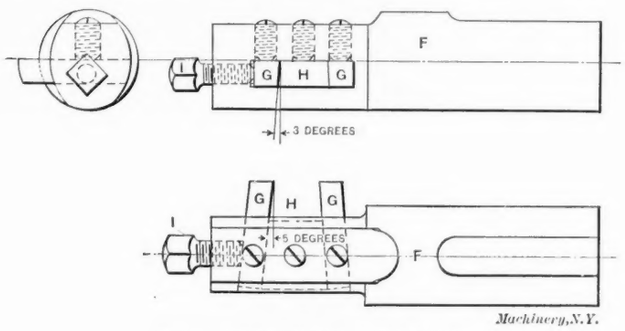


Fig. 2. Straddle-tool for facing Collars.

After the collars have been bored, reamed, and faced, they are strung on a special mandrel (which holds eighteen at one time) and splined. They are now ready to be turned to the required outside diameter. The collars are splined before turning the outside, because the mandrel shown in Fig. 3 is provided with a feather *L*, which acts as a driver. A heavier cut and a coarser feed can be taken when driving in this way, and a number of collars can be securely held and turned at one time.

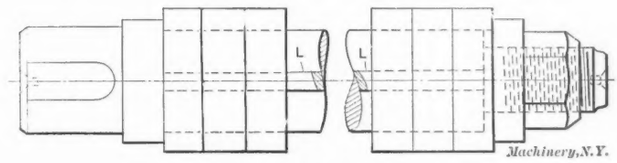


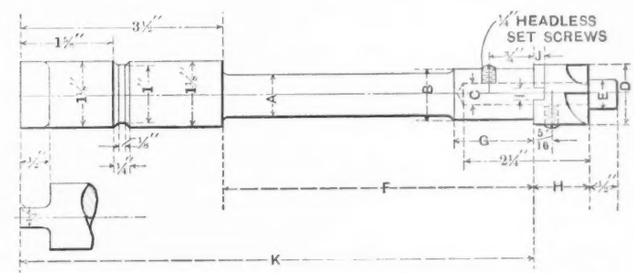
Fig. 3. Mandrel for holding Spacing Collars.

CHARLES THIEL.

Lawrence, Mass.

TABULATING DIMENSIONS OF TOOLS.

The cut shown herewith shows an idea which will be very acceptable to all tool designing rooms, and also to all regular drawing rooms making tool-room drawings. The foreman of the tool-room wanted sketches of a number of sizes of counterbores, having various sizes of pilots, and all fitting the same spindle. To save time in drawing, tracing, and blue-printing, I have standardized a sheet, as shown in the cut. All dimensions which are constant are given in their proper places on the drawing itself, while all those which differ for different sizes are indicated by letters, and tabulated. Vacant columns are left in the table of dimensions, and the tool-maker foreman can now supply the required figures for any new sizes he wishes to make, and turn the print over to his workman without waiting for another sketch. This idea can be used for a great variety of tools and fixtures, and we find it a great saver of time. TOOL DESIGNER.



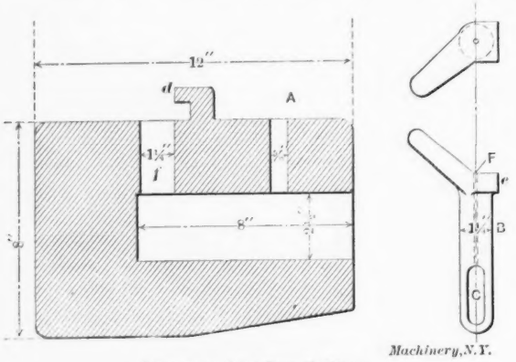
No.	A	B	C	D	E	F	G	H	I	J	K
1	¼"	¾	5/16	¾	⅜	4		1	3/16	3/16	7½
2	¼	¾	5/16	⅝	5/16	4		¾	⅛	⅛	7½
3	¾	⅞	⅜	1	⅜	4	1⅜	1	3/16	3/16	7½
4	1¼	1⅜	½	1½	⅝	4	1⅜	1¼	¼	¼	7½

Example of Tabulated Tool Dimensioning.

[A system that in some respects is even better than the one mentioned by our correspondent is in use in some drafting-rooms. Instead of inserting letters for variable dimensions and tabulating them, the spaces where the variable dimensions are to be given are marked on the tracing with circles filled in with india ink, thus producing on the blue-print a white spot on which the dimensions can be conveniently and plainly filled in with ink. The work of filling in the dimensions on the various blue-prints is hardly more than that of tabulating; but the advantage gained of having one distinct blue-print for each tool aids greatly in preventing mistakes in the shop, due to reading the dimensions wrong in the table.—EDITOR.]

CANNON FOR SHOP USE.

The cut shows a cannon which is used principally for driving large keys. It is a breech-loader, and because of this, has an advantage over the one shown in September MACHINERY. This device, which has been in use for many years at the Portland Company's shops, Portland, Me., was designed for driving the keys on the paddle wheels of side-wheel steamers. The barrel *A* is of cast iron, and of the dimensions given. There are four ¾-inch eye-bolts tapped into the sides, to facilitate handling. Three ⅝-inch holes are drilled as shown, for the escape of the gases. The powder is placed into the cavity *C* of the breech plug *B*, and covered with a piece of tissue paper which has been moistened to make it



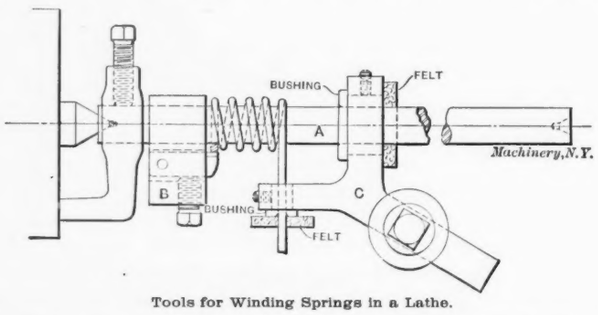
Cannon and its Breech Plug.

stick. The breech plug is then inserted in the hole *f*, and the handle turned so that the lug *d* engages with the projection *e* on the plug, holding it securely in place. The shot, which consists of a hardened piece of steel, about six inches long, is placed in the muzzle, and the cannon is fired with ordinary cannon primers, which are placed in the ¼-inch hole *F*, in the breech plug. A string about five feet long is attached to these primers, and in this way they are exploded. In driving keys, coupling bolts, etc., it is not necessary to chain the cannon, as its weight will take care of the recoil. There is very little danger attached to the use of this device, if the breech plug is cooled before it is reloaded. After firing, the barrel should be swabbed out, first with wet, and then with dry waste. Of course, the usual precautions in handling gun powder should be observed. H. K. GRIGGS.

Portland, Me.

TOOLS FOR WINDING SPRINGS IN AN ENGINE LATHE.

The manufacturing concern by whom I am employed use a great many small compression springs, made of red bronze spring wire, in a variety of sizes and lengths. As it has not been possible to buy springs of sufficiently accurate or durable quality, it fell to my lot to make them on something like a



Tools for Winding Springs in a Lathe.

commercial basis, and at the same time without spending much money for tools, as it was hoped we could buy them outside when the demand became greater. It is necessary that these springs be set, or squeezed together once only, after being wound, since they are never compressed again to that extent in service. It is thought that they will then fill the space they are supposed to occupy for a longer period of time. By referring to the accompanying sketch it will be seen how they were wound and compressed, or set. *A* is the mandrel which is made of drill rod, in a variety of sizes to suit the springs to be wound. Each size mandrel has fastened at one end a piece *B* in which is pivoted a beveled edge tool steel piece, which in connection with the set screw shown holds the end of the wire being wound.

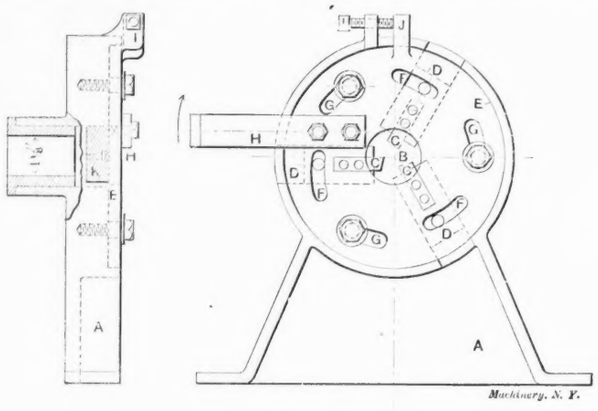
This method of fastening is a great improvement over the usual hole in the mandrel, as the wire never breaks off, as it does with the hole, and the spring can be taken off the mandrel without cutting the wire at that end, as is necessary when a hole is used.

Piece *C* is a forked piece which is held in the tool post of the engine lathe. One end of piece *C* is bored to receive guide bushings for the different sizes of wire to be wound. The other end is bored to receive bushings for the different sizes of mandrels. The end which passes over the mandrel serves a double purpose. It acts as a follower rest, making it possible to use long, slender mandrels. It is also used to compress the springs. By releasing the nut from the lead-screw, the lathe carriage can be moved by hand toward the head-stock until the spring is closed up solid, and then released again and taken off the mandrel, and the operation repeated. The springs are then cut up into short lengths on the punch press, using a stop so that each spring will have the same amount of wire in it. As there was formerly a short piece wasted on each piece wound, the saving in winding as long as possible will be apparent. Eighteen per cent was scrap wire. We now lose less than two per cent. It will be noticed that the holes in the bushings are rounded at the ends, also that pieces of felt kept filled with oil are fastened where the wire and mandrel pass through them to keep from roughing up the wire and mandrel. These little points are very important, as they often spell success or failure for tools.

C. G. H.

CUTTING TRIPLE THREADS.

The accompanying cut illustrates an economical device for cutting triple threads. The frame *A* is bolted to the lathe carriage, and it is of such height that the center *B* is in line



Device for Cutting Triple Threads.

with the lathe centers. The cutters *C* are held in slides *D*, which slide in grooves planed in the circular part of the frame *A*. These slides are held in place by a circular plate *E*, which also serves to move the slides in and out, through the medium of the cam slots *F* acting on pins in the slides. Plate *E* is held in place by bolts in the slots *G*. A handle *H* serves to rotate plate *E*. A set screw *I* in a lug cast on frame *A* bears against a lug *J* on plate *E* and acts as a gage to vary the depth of cut.

The tools or cutters *C* are set in the slides *D* so that the top surface is in line with the center *B*. They are fastened to the slides by screws as shown in section at *K*, and they are all set in the same plane so that each one cuts a different thread. At the head-stock end of the lathe a slide is bolted, which engages with arm *H* and throws it up in the direction of the arrow thus drawing the cutters back at the end of the cut. A removable bushing provides adjustment for cutting threads on rods of various sizes. With this device four feet of triple square thread 1⅛ inch diameter and ¾ inch pitch can be cut in twenty minutes. FRED SEABURG.

Chicago, Ill.

GRINDING THREADING DIES.

In the November issue of MACHINERY appeared an interesting article on the subject of grinding threading die chasers. The points brought up in this connection were rather interesting, but the same trouble as met with by the author of that article may be caused in other ways than the one which he mentions. While not disputing the former writer's opinions, or his remedy, my own experience in regard to the grinding of threading dies has been that they cause trouble on account of not being ground or chamfered in a common sense manner. The die may be to all appearances in perfect condition for doing good work and have an equal chamfer on every land, but the chamfer may not be of a kind that actually does much good. In nine cases out of ten, in manufactured dies, one will find that the chamfer is made on the lines indicated in Fig. 1, which is, to any one analyzing the subject, entirely

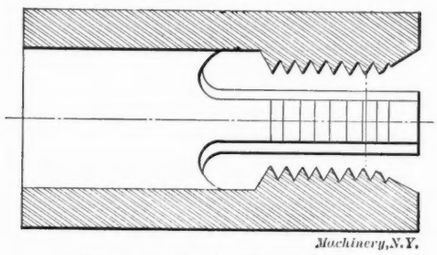


Fig. 1. Die not chamfered properly.

wrong. This die has the appearance, when examined, of having a very liberal chamfer, but the actual fact is that this die has only about 1 to 1½ threads chamfered. Now, whether ground in one way or another, these 1½ threads will have all the cutting to do, and, consequently, will have a tendency to "dig in." The land that digs into the metal first will, of course, leave little or nothing for the other lands to cut. I think that it is right here where the difficulty lies. That would coincide with Mr. Cleverdon's experience, as he says that on dies with a long chamfer, that is, where the chip is distributed over several threads, the difference in the total lengths of the cutting edges becomes negligible, and the remedy he mentions would not be necessary to apply. All his trouble

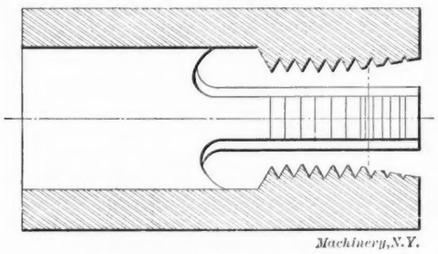


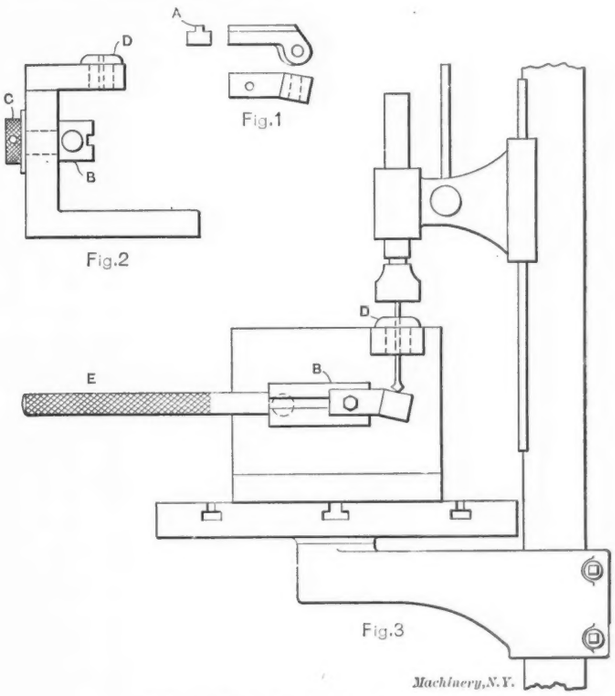
Fig. 2. Die correctly chamfered.

has been met with in dies with but short chamfer. My personal experience indicates that if a die is otherwise well made in all respects, and then has a chamfer like the one shown in Fig. 2, there would be no difficulty. The thread of the die should never be chamfered more than to the root of the thread. Whatever chamfer is made above this line is absolutely useless unless it be that the turret and spindle of the screw machine in which the die is used should be so much out of line that the die would have to act as a guide for the blank, in which case a chamfer like that shown in Fig. 1 would come in quite handy. It might also be argued that a die held in a *loose* die holder must have a chamfer like that shown in Fig. 1, in order to start properly, but even in this case a chamfer as shown in Fig. 2 should be used, and the blank to be threaded should be chamfered before it is presented to the die.

A.

METHOD OF DRILLING CURVED HOLES.

The accompanying cuts illustrate a method of drilling holes through needle guides, the holes following the arc of a circle. Fig. 1 shows the guide after it is finished. The tongue-piece *A* is milled so that it fits into the groove of the holder *B*, Fig. 2. This holder fits closely into a hole in the angle plate, and it is held against the plate by the nut *C*, which is just loose enough to permit the holder being turned on its axis. The drill bushing *D* is located above the work as shown. The hole through the bushing which guides the drill is made to fit the shank of the drill instead of the point. The drill is flat pointed, and its shank is much smaller than the point, so that it will allow the work, when being drilled, to turn without rubbing against the shank. The reamer is of the



Drilling a Curved Hole in a Needle Guide.

ball type, and it is essential that the ball be round, if the hole is to be accurate. The shanks of both drill and reamer are ground and lapped to fit the hole in the bushing *D*.

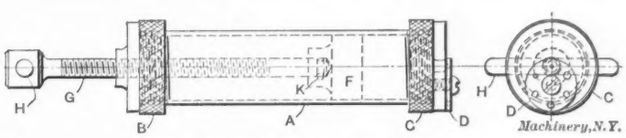
Fig. 3 illustrates the way in which the jig and the work are placed on the drill-press. The work is fastened to the holder by a bolt, as shown, and its position located with a height gage. By pressing down on the handle *E* the work is fed against the drill, and the hole is drilled on an arc, the radius of which will depend upon the distance from the axis of the holder to the drill.

K. R. CROSS.

S. Boston, Mass.

DEVICE FOR MAKING WAX FILLETS.

The accompanying cut shows a device for making wax fillets, which I came across the other day. As a good method of making the various sizes of wax fillets used on wood pattern work, at the time and in the exact quantity needed, I think this tool will be acceptable to any up-to-date pattern shop owner or pattern maker. The device is nearly self-explanatory, but a short description will serve to make its work-



Device for making Wax Fillets.

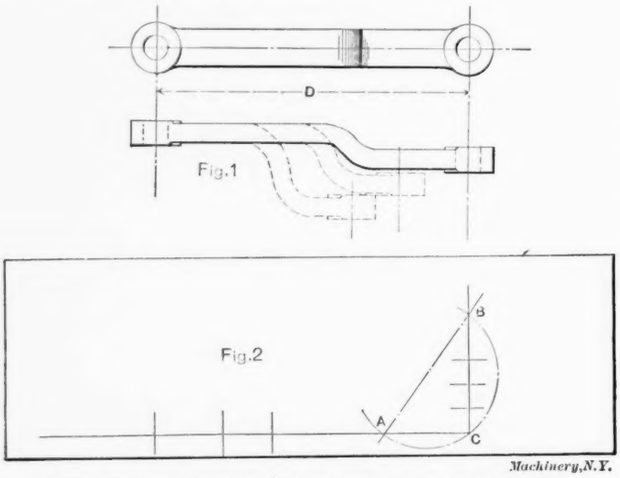
ing more clear. The barrel *A* is a piece of seamless brass tubing. The cap *B* is made of soft machinery steel, tapped to fit the compression screw *G*. This screw is fastened to the plunger *F* by the pin *K*, allowing the screw to turn without turning the plunger, but preventing its withdrawal in backing off. The cap *C*, also of soft machinery steel, has a hole in the center slightly larger than the largest size of fillet it is desired to make. The circular plate *D* is made of sheet steel, and drilled with different sized holes to correspond with the sizes of fillets wanted. It is screwed to the cap *C* so that

the holes will coincide with the central hole in the cap. The working of the device is obvious. By warming the barrel after filling it with odd pieces and scraps of wax, and setting the plate *D* for the size wanted, the fillet is made by turning down the compression screw with the handle at *H*.

Detroit, Mich. M. R. KAVANAGH.

LAYING OUT OFFSET LEVERS.

During my stay with an automatic machinery company in the East, I had a number of cast iron levers with various offsets to lay out. These levers were made as shown in Fig. 1, and the distance between centers was given on the blue-print as indicated. It was important to get these dimensions within close limits, so I went about the work as follows. I took a piece of sheet iron, Fig. 2, and with scale and scriber drew a base line. With the dividers I erected a perpendicular at the end of this base line, in the manner shown, and stepped off on this perpendicular the offsets of the different levers. Then, from the intersection of the perpendicular and the base line, I measured off the distance between the centers of the levers. It now only remained for me to set the dividers on the proper center dimension on the base line, and the corresponding offset point on the



Offset Lever, and Method of making Lever to Required Dimensions.

perpendicular, and transfer this to the right lever, estimating with my eye the location of the center of the bosses at the same time. E. R. SEITER.

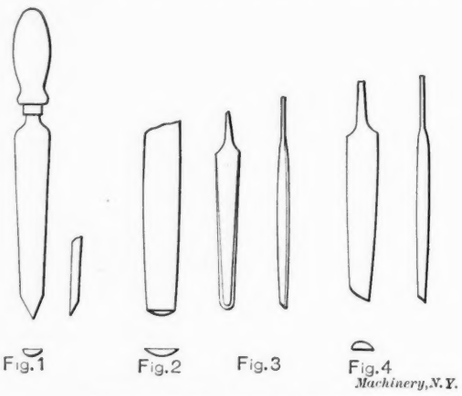
Chattanooga, Tenn.

[The manner in which our correspondent erected a perpendicular to the base line may not be clear to all readers of MACHINERY. The detailed procedure is as follows: Draw any circle with its center outside of the base line, so that its periphery intersects the base line. From one of the intersecting points *A* draw a diameter through the circle, intersecting the periphery again at *B*. From *B* draw a line to *C*, the other intersecting point between the circle and the base line. The angle *A C B* is then a right angle, or, in other words, *B C* is perpendicular to the base line.—EDITOR.]

TOOLS FOR SCRAPING.

Every once in a while it becomes necessary to scrape out a hole in order to true up a certain surface, or clean up a bearing and leave it as large as possible. Almost everything from a chisel to a file is used with varying degrees of satisfaction. The proper tool is a half-round file, ground on the flat face and pointed to an angle of about 60 degrees. One edge is sharp, and the other rounded slightly, as shown in Fig. 1. All the pressure that is put on the end of the handle goes to the cutting edge, and the hole is not marred nor does the tool slip. Another job is the scraping of semi-cylindrical holes in steel, such as drop forge dies, etc. The ancient hook or draw scraper is generally used, in spite of the fact that one cannot see the cutting edge. The proper tool to use is an end-cutting scraper made of a half-round file, Fig. 2, ground to a smaller radius than the work. The great fault with most scrapers, in steel work especially, is too great a length of cutting edge, requiring too great a pressure to keep it cutting. Therefore, slightly round the face and edge of the tools, and keep them always sharp, and stone as soon as they slide or tear. A coarse India stone and a bit of waste soaked in turpentine is often as essential on fine steel work as the scraper itself.

For plane surfaces, sharp corners, etc., the tool shown in Fig. 3 is handy and useful. This is also made of a half-round

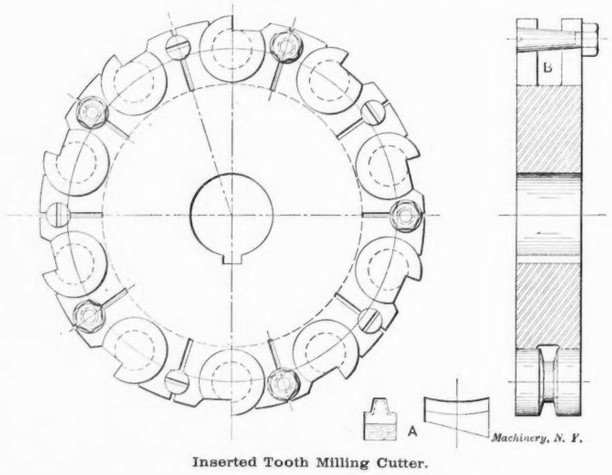


Scraping Tools of Various Kinds.

file. It is sometimes given quite a relief, as compared with the usual end cutting tool, the cutting edge being ground to about 70 degrees. These tools will stand up for a long time on unannealed tool steel and saw steel. Fig. 4 shows a half-round scraper used for the last thousandth in cylindrical work in the lathe, especially steel, and for smoothing out holes. The back edge is rounded so as not to mar the work and the long curved edge avoids chatter from too long a cutting edge, and permits cutting where it is needed. SIRIUS.

INSERTED TOOTH MILLING CUTTER.

The accompanying cut shows an inserted tooth milling cutter, designed to manufacture the brake shoes shown at *A*, in which it is necessary to keep both the form and the radius of the cut to gage. The principle of the inserted teeth is the same as that of the circular forming tools used on screw



Inserted Tooth Milling Cutter.

machines, the teeth being sharpened radially. The taper studs are used to secure the teeth in place by forcing the slots open and binding the body of the cutter on the teeth. The cutter-holding body is grooved in the center to reduce the body of metal to be sprung out in order to bind on the outer edges of the teeth or cutters. As the teeth become dull, they can be ground while in place a few times, before being loosened and again set radially. The advantage of this form cutter is that the teeth can be ground to shape after being hardened (because they are circular) which is impossible with the ordinary form cutter, but often very necessary when the pieces milled have to be correct within small limits. This permits the use of Novo or other high-speed steel, which

ordinarily cannot be used for form cutters, as the outside is burned in hardening. Broken teeth can be easily replaced. No backing off machine, or fixture, is needed for making the formed teeth, which will appeal to small shops which get an order to make a few thousand duplicate parts. The cost of material is considerably reduced as compared with a solid form cutter. Within its limits different kinds of teeth can be used in the same body, but this is only recommended when the removed cutters are of no further use.

Candiac, Canada. S. A. McDONALD.

[One weak point in this design of cutter seems to be the cutting of the central groove *B*, which naturally permits the outer edges of the cutter body to bend inward when the nut on the tapered pins is tightened for binding the blades. Another objection is the projection of the nuts outside of the cutter body, as it is never good practice to have projections of this kind on rotating bodies if it can be avoided. These objections, however, are mere details, and can easily be overcome. The principle of the cutter itself is very commendable, and may also be of value as suggestive of similar adaptations for a multiplicity of work.—EDITOR.]

FACING WORK BETWEEN CENTERS.

After reading in the October issue of MACHINERY the criticisms of my article on facing work, I called on an expert machinist and tool-maker and inquired as to his practice. He stated that his practice had been for some years past exactly in line with what I stated in the article, and that he had never considered the half-center necessary in lathe work. Mr. Simonds wants to know how I would cup the center of an arbor. Well, if only one arbor was to be cupped I might use the same side tool that was being used to face the end of the arbor. To demonstrate that there is no difficulty in doing this, the expert referred to, in my presence, faced and cupped an arbor with a side-tool without slackening the tail spindle; and he used less time than Mr. Simonds would probably use to change centers and do the work. When there are a considerable number of arbors to center and cup, it is better to use a universal chuck and steady rest. By this method, each center may be drilled, reamed, and cupped, at one setting of the work. The material that arbors are usually made of is nearly enough round to be run in the steady rest. Lapping the centers after hardening the arbors corrects minute irregularities.

I admit that a side-tool used in connection with a half center may be of such a shape as to stand more crowding than will the side-tool I described, and I am glad that Messrs. Simonds and Allan pointed out the advantages of the half center. But Mr. Allan is certainly far from the truth in intimating that the tool I advocated would fail after facing one piece. If he got such poor results, possibly the fault was in the quality or temper of the steel. In using poor steel we have the same trouble with the point of a V-thread tool.

Anticipating questions as to the method of cupping the arbor, it may be explained that the side-tool used in the example cited was of a sufficiently sharp angle to admit of setting the tool around to the right for cupping. To get a smooth job, high speed and fine feed were used. While the tool is stronger than it looks in the sketch accompanying my previous article, for ordinary facing its strength could be increased by making the angle at the point just a little less than 60 degrees, a center gage being used to test it by. The tool should not be used for end cutting, except for a light finishing cut. W. S. LEONARD.

Atlanta, Ga.

The letters written by Messrs. Leonard and Allan which have appeared in recent issues of MACHINERY are timely. They bring up a subject which, though simple, is well worth consideration. I differ with Mr. Allan as regards the efficiency of the tool described by Mr. Leonard. I find that it does all that he claims for it. Allan says this tool does not hold its edge. I gave a tool, ground as Mr. Leonard describes, a month's trial, and I am well pleased with the results. One reason that the tool dulls quickly, in common practice, is due to improper care in feeding the tool toward the lathe center. The work at the center is turning very slowly in comparison to its outer edge. For this reason the speed of travel of the tool should be decreased as the tool comes nearer the center of the work, else the tool will be moving faster lineally than the work is revolving. This will cause the work to tear, spoiling its finish, as well as dulling the point of the tool. It is also essential to the life of the tool that its point be in line with the lathe center. Should it be above or below the center, it will be subject to a rubbing or scraping action that will quickly dull the tool. It may be well to say, that the test I gave the tool described by Mr. Leonard, was made on high-grade carbon steel. WM. H. ADDIS.

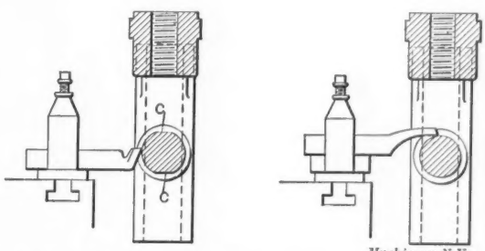
Decatur, Ill.

I have noticed several suggestions in the August, October and November issues of MACHINERY about facing work on lathe centers. Why face the work on centers at all? This is my method: One end of the work is held in the chuck and trued up roughly; the other end is put in the steady rest. Then the end is faced with an ordinary diamond point tool. A tool shaped like a flat drill, with an angle of 60 degrees, is clamped in the tool post and brought up to the center of the shaft where a slight cut is made for the center drill to enter into. After drilling the center hole to a sufficient depth, the flat drill-shaped tool is again brought up, and the center is cut to the right size, using only one cutting lip. A center formed in the foregoing manner is bound to be perfectly true with the periphery. G. E. DANIELL.

Augusta, Ga.

TURNING THE WRIST-PIN OF A CROSS-HEAD.

Turning a wrist-pin which has been cast solid with the cross-head is a job that a few years ago was much more common than at present, although even now it is sometimes necessary to do work of this kind. To turn the pin, and get it round and smooth, requires considerable skill on the part of the one doing the work. Before the wrist-pin is turned, the cross-head should be bored and planed. It should then be carefully centered in such a way that a line passing through the centers will be at right angles to the hole for the piston



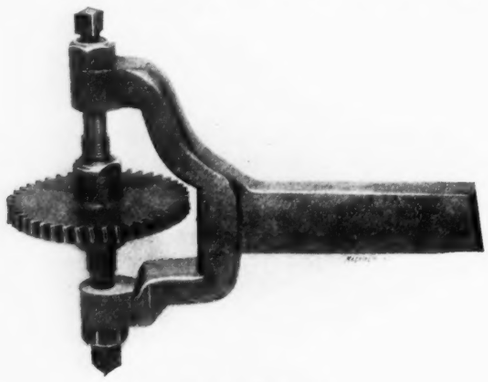
Figs. 1 and 2. Tools used for turning the Wrist-pin of a Cross-head.

rod. After the cross-head has been placed between the lathe centers, a wooden handle should be inserted in the piston rod hole. This handle enables a man behind the lathe to turn the cross-head back and forth on the lathe centers, while the operator feeds the tool for every forward stroke. For the first cut an ordinary round nose tool is used, as shown in Fig. 1. Of course it is necessary to take light cuts. From 120 to 180 degrees of the circle can be reached with this first turning. The position of the cross-head is then reversed, and a cut taken over the opposite side of the pin. It is well to cut clearances *C* for the tool at the beginning and the end of the cut. These clearances can be chipped by hand, but if there is much metal to remove, a slotter should be used. After as much of the pin's surface as can be reached with the ordinary tool, has been roughed out, another tool, shown in Fig. 2, is used to remove the remaining metal. The tools are now ground for finishing cuts, and the above operations repeated. The rough spots, which will be found at the points where the tool marks intersect, can be smoothed off with a fine file. If this part of the work is done properly, the job will be entirely satisfactory. W. L. MCLAREN.

Ottawa, Ont.

WORM-CUTTING TOOL.

The half-tone herewith illustrates a worm-cutting tool which does away with a great amount of work. When using this tool, the worm thread is first roughed out in a lathe, so that the depth of the thread is about one-quarter of the depth of thread wanted in the finished worm. The worm is then put on an arbor and finished with the tool shown, which is held in the tool-post and permitted to revolve freely. The advantage of this method is the ease of sharpening the cutter,



Worm-cutting Tool.

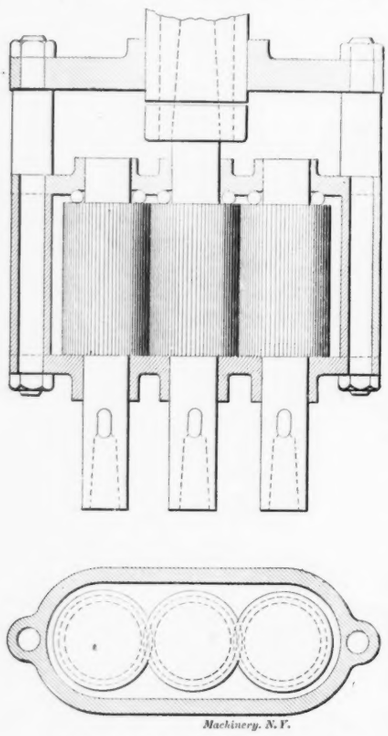
combined with the true shape obtained in the worm thread, it being cut by the generating process. The method of making the cutter is exactly the same as that used for hobbing an ordinary worm-wheel, except that the edges are not beveled off as in a worm-wheel. Instead, the upper side of the cutter is slightly concaved, so as to produce a better cutting edge on the teeth.

ALBERT ANDREWS.

Chicago, Ill.

MULTIPLE SPINDLE DRILLING DEVICE.

In a large number of gears three pin holes were to be drilled through one of the arms, comparatively close together, too close, in fact, to permit the use of an ordinary multiple spindle drilling machine. For this reason, the device shown in the cut was designed to be attached to an ordinary drill press. The three pinions are made of steel, and drill sockets and pinions are made in one piece. Ball bearings at the end of the pinions take the end thrust. In order to prevent the device from revolving with the drill press spindle, a yoke clamped to the spindle sleeve is secured to the gear case by short, stiff tie rods. The drills used with this device are of the inserted blade type, having soft steel shanks with four high speed steel blades, one of the drills cutting right-hand, and the other two left-hand.



Multiple Spindle Drilling Device.

Y. Z.

SHOP LIGHTING.

It is announced regarding the construction of a certain new manufacturing plant that the windows will *not* be frosted, and that the workmen will be able to see the beautiful park adjoining by simply looking up from their work. Such a view is not obtainable from every shop, but the adverse effects of the translucent pane are much more clearly realized now than when this style of glazing was first installed. A man may work in front of a blank wall without serious protest, but there is something peculiarly irritating in being compelled to stand day in and day out before a window, with a mental realization, but not a visual perception, of the view without. If the human interest to see the world outside is not satisfied, there seems to be a deadening influence which has its effect in reducing efficiency. Of course, there are conditions where only distraction can result; when the view becomes a motion picture, a sort of continuous show. Broadly speaking, however, experience has shown the unwisdom of setting the entire sash in translucent glass, and the advantage of the shop in the open country, with its touch of nature in the view. In so far as ribbed or prismatic glass may be essential to the better illumination

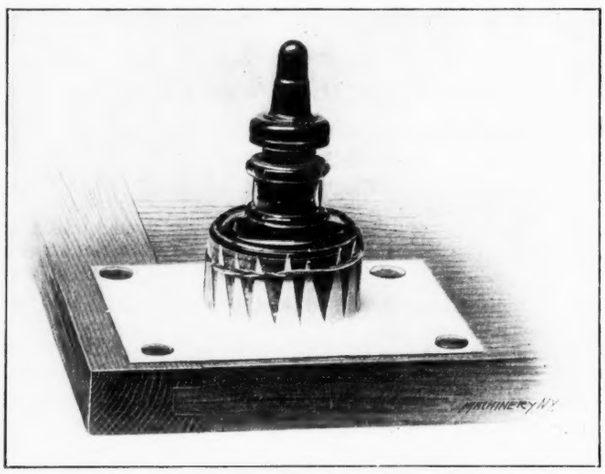


Fig. 1. Securing the Ink Bottle.

of the interior, it may be set in the upper part of the sash, leaving the lower portion clear, but the idea of the prison cell should be removed from the mind of the workman. Incidentally, the difference in lighting value between a clean and a dirty window should not be overlooked. In a certain shop, lighting up was not necessary for an hour later in the day, after the windows were washed.

W. B. S.

SECURING THE INK BOTTLE.

The greatest efficiency often lies in the greatest simplicity. The illustration, Fig. 1, shows one of the most effective means of preventing what has always been a source of great annoyance to the draftsman, *viz*, the overturning of the ink bottle. In the center of a four-inch square of ordinary drawing paper, scribe a circle equal to the diameter of the ink bottle. Divide the circle into about twenty-four parts, as shown in Fig. 2, then with a sharp knife, cut the paper from each of these twenty-four points to the center, following a radial line. Press the paper down over the neck of the bottle. Around the paper points, which stick up around the bottle like a picket fence, put six or eight ordinary elastic bands. Thumb tacks in opposite corners will securely hold the entire outfit to any part of the board desired.

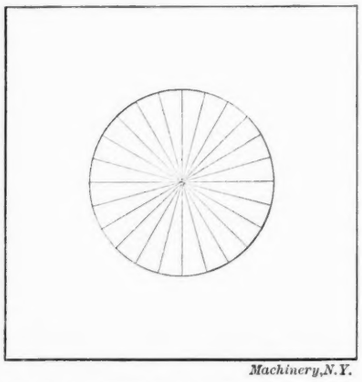


Fig. 2. Layout on Piece of Paper for making Ink-bottle Holder.

C. H. RAMSEY.

Paterson, N. J.

CONTOUR GAGE.

The accompanying cuts illustrate a special tool which we have found of great value in certain classes of work. The need of some such device became apparent when patterns and core boxes were required to be accurately checked with the drawings of a certain brass specialty concern. The tool

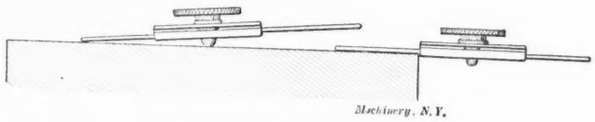


Fig. 1. End View of Contour Gage.

is applied to the work, and the wires pressed down onto the contour by using the side of a lead pencil. Of course, patterns parted on the center could have their halves laid directly on the drawing without using the contour gage, but our patterns were carded and inseparable. Such a tool proves a relentless check upon the patternmaker, who, by

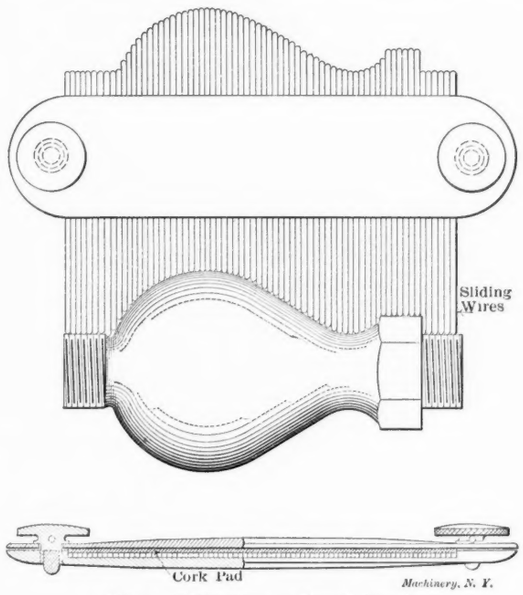


Fig. 2. Setting Gage to Turned Sample.

making the patterns larger than necessary, can cause a considerable loss in a business where thousands of casts are made yearly from the same patterns. As a ready and universal templet it is the best I have seen. HOWARD D. YODER.

GALLING OF METALS.

There is rarely any little mishap in shop practice that will cause more annoyance than the galling of a shaft, or mandrel, in its enveloping piece. This is most likely to happen when the inner and outer pieces are of the same material, but it occasionally occurs when the materials are different. Such a mishap is nearly always due to the lack of oil. When cutting a thread in a casting, which is to be fitted to a screw by the cut-and-try method, oil should be used on the screw very sparingly, because it would otherwise be transferred to the internal thread, making it difficult to dislodge the fine chips. For this latter reason, a certain machinist in making a new face-plate, tried it on the lathe spindle without any oil. He succeeded in screwing it up against the collar, but on unscrewing the plate, it galled to such an extent that it became necessary to split the plate in two parts to save the thread on the lathe spindle. When trouble of this kind is caused by the fine chips which are apt to adhere to the threads of a face-plate, it can be almost entirely eliminated by cutting two shallow key-ways, one through the hole in the face-plate, and the other on the threaded part of the spindle. These key-ways scrape the thread clean, and they are also a receptacle for the dirt.

A peculiar example of galling, and one which the writer has observed but three times during a long experience, is that of the lathe center galling in the work. A case of this kind happened in connection with a "hurry-up" job, which a certain man had charge of a few years ago. He was very nervous, and impatient, and generally underestimated the time required to do any piece of work. Being dissatisfied with the progress of some lathe work that was being done for his job, he requested the foreman to let him do the turning, declaring that "he could do the work while Jim Slowcoach was getting ready to do it." He was given a lathe and told to go ahead. He started in with a heavy cut, and coarse feed, and

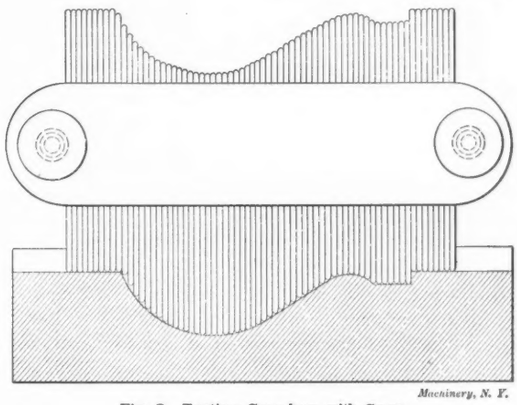


Fig. 3. Testing Core-box with Gage.

was so busy in trying to keep the belt from slipping, that the insignificant matter of oiling the lathe center was overlooked. Suddenly the work dropped to the floor, and he was surprised to find that about half of the conical part of the right-hand center had been sheared off. On examining the work, he discovered that the end of the center had galled in the work so tightly that it appeared to be welded. This could not have been the case, however, as the heat caused by the lack of oil was certainly below that of fusion. Nevertheless, the center had to be cut out with a chisel.

A large boring bar or mandrel should have an oil hole drilled from the periphery to the extreme end or bottom of the center, and this hole should be tapped and fitted with a small plug. If, in addition to the oil hole, three equidistant shallow oil grooves be cut in the conical part of the center, without extending quite to the outer end, the combination would make a perfect self-oiling arrangement. A single groove in the conical part of the lathe center will enable the workman to oil the center without slackening the tail-spindle, but the plugged oil-hole has an advantage, as it provides a reservoir of oil, and a continuous feed. One objection to slackening the tail-spindle for oiling is that oil thus applied is likely to wash fine chips between the lathe center, and the work center, and cause the work to run out of true.

For heavy lathes, a very efficient center oiling arrangement may be made by drilling a small hole axially in the outer end of the dead center, and then drilling a larger hole at right angles to, and meeting the small hole. To insure an ample supply of oil, the large hole might have an oil tube or an oil cup. W. S. LEONARD.

Atlanta, Ga.

* * *

Pure putty is usually made in what is known as a "chaser," of whiting and linseed oil. The proportions are about eighty-five pounds of whiting and fifteen pounds of raw linseed oil. Bolted American paris white is commonly used in this country for the purpose, though imported whiting may also be used. Of course these proportions are only tentative, and must be varied according to the consistency of the mass produced. For quick drying putty, boiled linseed oil is used instead of raw, and about ten per cent of dry white lead is added to the whiting. This is the old receipt for pure putty. At the present time, however, very little commercial putty is made according to this formula, large proportions of crude cotton seed oil (known in trade as "putty oil") being substituted for some of the linseed oil, and boiled linseed oil being used instead of raw to counteract the slow drying qualities of the cotton seed oil. Instead of fine paris white, common whiting with varying proportions of fine marble dust is used.—G. R Heckel in *Trade Press List.*

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

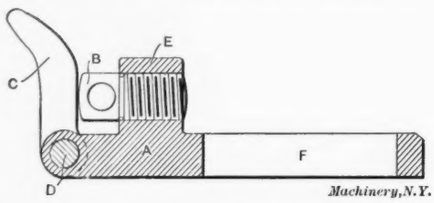
SUBSTITUTE FOR THUMB-TACKS.

It is very exasperating to have a triangle or T-square catch on the head of a thumb-tack, when making a drawing. In the drafting room where I am employed, we have the regular thumb-tacks, but very few of them are used. We use instead a very small iron carpet tack, being the size used to fasten window shades to the rollers. A magnetic tack hammer is employed to drive them. These tacks can be driven in until the head will not catch on the triangle or T-square, and, being very short, are easily extracted. Five cents' worth of these tacks will last as long as a dollar's worth of thumb-tacks, and they have the additional advantage of *not* standing point upwards on the draftsman's stool. A DRAFTSMAN.

[In some drafting rooms small copper tacks are used as a substitute for thumb tacks. The copper tacks, being softer than iron carpet tacks, have the advantage of flattening out entirely to the surface of the paper, presenting no projection whatever. They, of course, are at a disadvantage as compared with the carpet tacks as they cannot be handled with a magnetic hammer.—EDITOR.]

HANDY PLANER DOG.

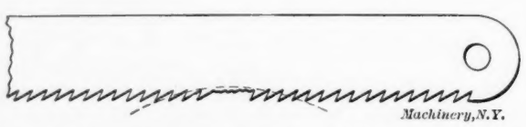
The accompanying cut shows a simple planer dog, which can be used to advantage on almost any class of work. On very heavy work, however, the relative proportions of the body *A* are rather light, and should be increased. The design of the appliance is very simple, and is plainly shown in the



cut. A body *A* is provided with a lug *E*, into which is threaded screw *B*, the other end of which bears against the binder *C*, swiveling around pivot *D*. The body *A* is clamped in the T-slots in the planer table, a long slot *F* being provided for adjustment. A drilled hole in screw *B* makes it easy to turn the screw when binding the clamp *C* against the work. O. G.

SAVING A HACK-SAW BLADE.

Most machinists have doubtless noticed that when one or two teeth break from the blade of a hack-saw others soon follow. This is especially true when the piece being sawed is narrow, because the saw drops when the space made by the

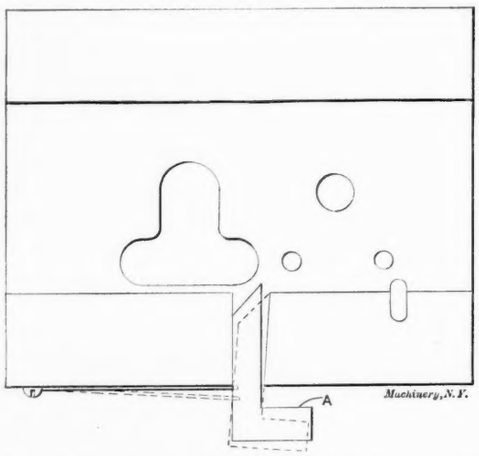


broken teeth passes over the work. Other teeth can be prevented from breaking out, by grinding two or three teeth on each side of the broken part, as shown by the dotted line in the cut. This will prevent the teeth which are next to the broken part from striking abruptly against the work. This kink may not be of interest to the man in a large shop where saw blades are plentiful, but it may be useful to those working in small jobbing shops, where very often the blade being used is the last one on hand. A. E. FISH.

Denver, Col.

STOP FOR STOCK IN BLANKING AND PROGRESSIVE DIES.

The stops which we use on all blanking and progressive dies are of the automatic type. The cut shows a die with stripper removed, but with guide plates and stop in place. The stock is fed up to the stop, which is so located as to give a whole blank the second stroke. As the punches descend, a pin engages the stop at *A*, and forces it out, but not until the pilot pin in the blanking punch has engaged the perforated hole in the stock. On the up stroke, the stop is released and is resting against the edge of the stock in a position indicated by the dotted lines. When the stock is pushed forward by the operator, the point of the stop engages a notch cut

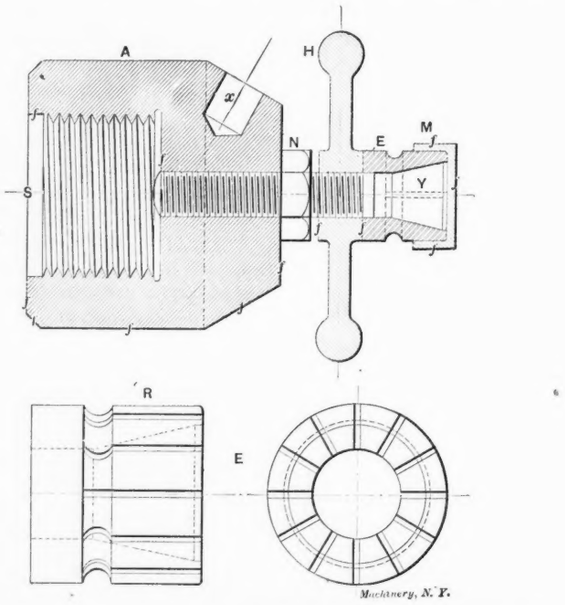


in the side of the stock, bringing it to a full stop when the back of the stop gets a bearing against the side of the slot in the die in which the stop is placed. As the punches descend, this performance is repeated. The pin, which acts as a trip, is made of ¼-inch cold rolled stock, filed to an angle on the end, and case-hardened. K. L. Ross.

St. Louis, Mo.

EXPANDING CHUCK.

A simple, but very effective, expanding chuck can be made as shown in the accompanying cut. The part *A* is made of machinery steel, and screws onto the lathe spindle at *S*. A rod of suitable diameter is inserted in the hole *x* when it is desired to screw the part *A* on or off. A lock nut *N* and a hand-wheel *H* are screwed on the expander *Y*. The expanding chuck *E* fits over the expander *Y*, and is made to expand by being forced against the taper part of the expander by



the hand-wheel *H*. The expander *Y* and the chuck *E* should be made of tool steel, and hardened. The surface *R* (see enlarged detail) of the chuck can be roughened for small, smooth work. This simple arrangement can be varied to suit any case where work must be held internally. The small piece *M*, which is to be finished as indicated by the finish marks *f*, is an example of the kind of work held by this chuck.

TOOL DESIGNER.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

TO LOOSEN PULLEYS WHICH ARE RUSTED FAST ON THEIR SHAFTS.

Referring to the "How and Why" question in the October issue asking how to remove pulleys rusted fast on their shafts, I would suggest heating the hubs and melting beeswax into the joints. Then drive the pulley with a heavy sledge, while hot. In this way I have been able to loosen pulleys and gears which could not be loosened in any other way. JOHN M. KUPEL.

Peoria, Ill.

In answer to N. M.'s inquiry in "How and Why" department of the October issue for a practicable method of removing pulleys rusted fast on their shafts, when a hydraulic press is not available, I would suggest that the hubs be wet with kerosene oil, and then fired. The quick heat will cause the hubs to expand sufficiently to loosen the rust and permit the pulleys to be driven off with a sledge. I have followed this method with success. WM. DAVIS.

Philadelphia, Pa.

In your October issue, under "How and Why," N. M. asks how to loosen some 48-inch pulleys which are rusted fast on their shafts. If he will heat the shaft and hub of a pulley to a temperature, say, that will turn the shaft blue and then place beeswax around the joint and let it run well, the pulley will loosen "as slick as grease." Beeswax congeals at a comparatively high heat, but when melted it is very thin and will run into any place that oil can reach, and is a better lubricant for a condition like this. E. W. NORTON.

North Tarrytown, N. Y.

In the October issue, under "How and Why," the question of how to loosen a pulley on a shaft was considered. If the shaft is mounted horizontally, I would build a wooden box around the hub, using as many pieces *A* as there are spokes, less one to leave an opening on top, and four pieces *B* clamped together (See Fig. 1.) I would heat the hub by pouring this box full of hot babbitt. The small pieces *C*, Figs. 1 and 2, serve to part the babbitt. Chalking will make the wood fire-

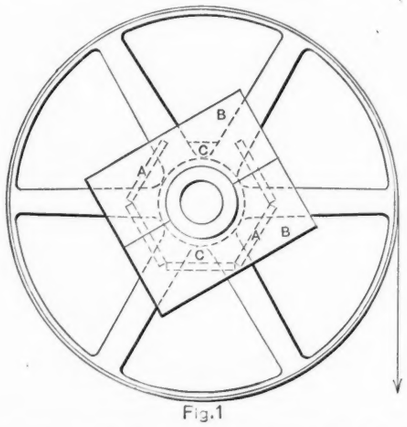


Fig.1

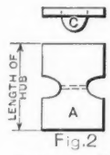


Fig.2

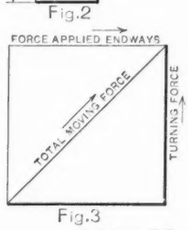


Fig.3

Machinery,N.Y.

proof. This is the quickest way of heating, and therefore the one that leaves the shaft cool. Instead of forcing the pulley endways only, I would also apply a turning force. I once had to remove heavy bolts on a marine engine. The sledge alone would not make them budge. I then thought of how, when moving a loose-fitting pulley along the shaft, we nearly always turn it at the same time. Acting on this idea, I applied a wrench to the head of the bolt, and this time the combined efforts of sledge and wrench made the bolt move. It seems to me this action can be explained by a parallelogram of forces, but there may be a better explanation. J. SCHURING.

Bangor, Pa.

FITTING KEYS IN KEYWAY.

N. R. T.—How should keys be fitted on engine cranks, flywheels, gears—especially gib-head keys? Is it not best practice to use gib-head keys where there is nothing else to keep the part from shifting endwise on the shaft, and to give it an ordinary sideways fit in the keyway, and a *good, strong driving* fit top and bottom?

A.—A key should be fitted first on the sides, as the sideways fit is the most important, but it should fill the keyway and bear lightly top and bottom. It is a mistake to fit top and bottom in preference to the sides. A key strongly driven, which fits on top and bottom only, tends to spring the hub and reduce the contact with the shaft. A key is much more likely to work loose when fitted thus than when fitted sideways, and it is in a far less effective position to resist the twist of the shaft. The use of a gib-head key is simply to facilitate removal when the inner end is not "get-at-able." It has no greater holding power because of the shape of the head.

TO OBTAIN THE HEIGHT OF THE MIDDLE ORDINATE OF AN ARC.

G. C.—Tell me how to find the height of an arc at its middle ordinate, having given the number of included degrees and the length of its chord.

A.—The height of the arc may be found by simple arithmetical calculations, if a table of sines is at hand. All engineers' handbooks, and many other books on engineering subjects as well, contain a table of sines. Inasmuch as we know the number of degrees in the arc, we know the angle subtended at the center. Suppose that the arc is 36 degrees, then the angle is that measured by 36 degrees. Half the chord is the sine of half the angle. Half the chord is to the radius of the circle as the sine of half the angle (ratio as given in the table) is to 1. From this proportion the radius is calculated, using the given numerical value for half the chord length. Suppose the length of the chord is 10 feet, then half the chord length is 5 feet. Also suppose that the angle is 36 degrees. In a table of sines we find the sine of 18 degrees (half of 36 degrees) is 0.30902. Then $5 : R = 0.30902 : 1$; or $0.30902\ R = 5$. Then $R = 16.55$. The cosine of 18 degrees is 0.95106, and the difference between it and 1, or 0.04894 is the versine or height of the middle ordinate with a radius of 1. We have found the radius of this circle to be 16.55; hence, the height of the middle ordinate for a radius of 1 must be multiplied by 16.55 to obtain the middle ordinate for a radius of this length. $0.04894 \times 16.55 = 0.81$ foot, the height of the middle ordinate on an arc of 36 degrees, having a chord length of 10 feet.

* * *

By the way, we are all excited over the records of the high-speed steels. But a glance around us seems to show that most of it ends in excitement. Is it the fault of the new steels, the machines, or the men that handle them? After the noise and smoke clear away, we find that things have a tendency to settle back into the easy-going run of ordinary practice. The machine tool manufacturers, however, are always ready to give to the trade any advantage that their long experience shows is worthy of serious attention. So we have to-day become so used to what were called new-fangled devices a few years ago, that few buyers would consider any machines not fitted with all these latest improvements, that have shown their value as cost-reducing elements in the manufacturing plant.

* * *

In our June, 1906, issue, engineering edition, we referred to the evil of employing female labor in foundries, and we now find that the delegates of the Iron Molders' Union, at their session in Philadelphia this summer, pronounced themselves as opposed to the employment of women and children in core-rooms and foundries, as being detrimental to the health, and contrary to the station in life for which they are intended. Here is a territory where upright employers and fair-minded employes may well coöperate, for it certainly is, in the long run, but a loss and a disgrace to the country, if the standard of our women is permitted to be lowered so as to be required to perform such work as is in the highest degree incompatible with American ideals.

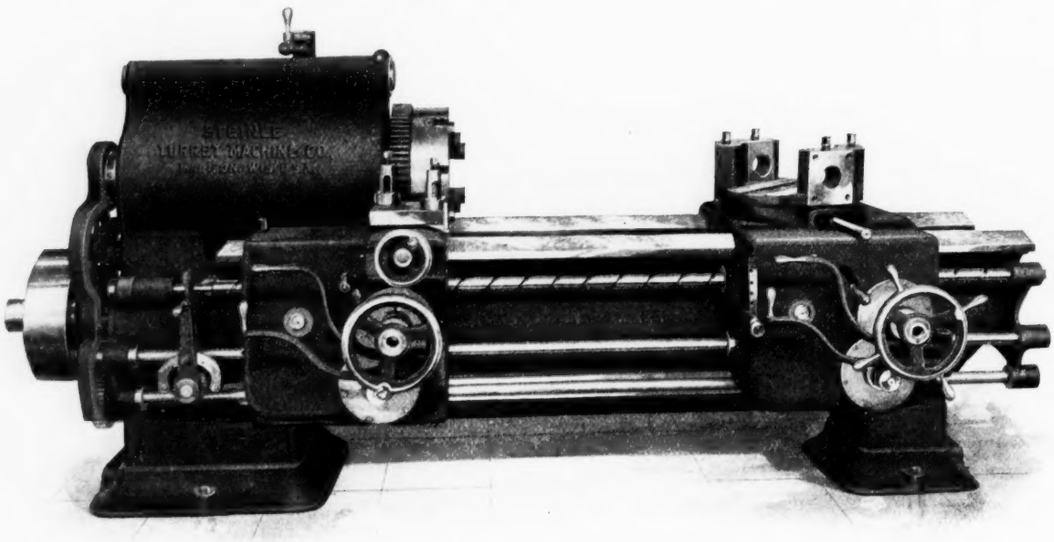
NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

THE FULL SWING SIDE-CARRIAGE TURRET LATHE.

The principal innovation in this interesting tool is indicated by its name. It was the experience of the designer of the tool, who has been connected with turret lathe work for more than twenty years, that the greatest objection to the two-carriage type of turret lathe has been excessive over-hang of turret tools required to reach the chuck over the width of the tool carriage. This great length of tool has resulted in weakness and vibration as well as inaccurate indexing. In the machine shown in the half-tone, this difficulty has been overcome by making the carriage of such a form that it may be in under the chuck, entirely out of the way of the turret slide, when it is necessary to bring the latter close to the face of the chuck.

This cross-slide carriage is supported at the front of the bed instead of extending across the top of the vees. It is supported at the upper vee, and has a bearing on a planed surface at the lower edge of the bed near the floor, thus giving as wide a bearing to resist the cutting strain as possessed by the ordinary form. The tool-post of this cross-slide is arranged on a turret base with facilities for holding four regular tool-posts, like the ones shown in the cut, or straps for flat cutters, if it is desired to use them.



Full Swing Side-carriage Turret Lathe.

Another novelty in construction will be noted in the shape of the main turret. The turret is hexagonal in form, four sides being finished with bored center holes and clamping surface for holding boring bars, etc., while the remaining two sides are open to receive universal facing heads for holding any form of facing and turning cutter. The turret is equipped with a rotating stock bar with a dead stop for each face.

Both turret and cross-slide carriages are provided with both turning and screw-cutting feeds. These feeds are entirely independent both as to rate and direction, and simultaneous cuts can be taken with each in the rate and direction desired. Owing to the weight of the slides necessitated by the heavy work for which the machine is designed, the plan has been followed of giving a power control for each of them, operated by handles within easy reach of the operater. This makes it unnecessary for him to tire himself by the rapid handling of these parts.

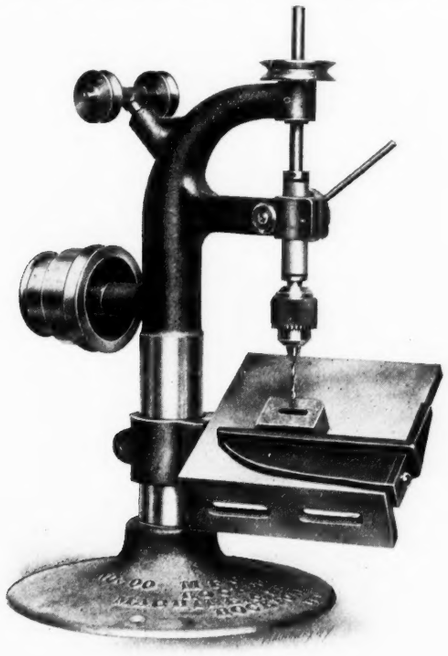
It will be noted that the head-stock and bed are made in one piece. This is an unusual construction for a machine as large as this, but it has several important advantages. It gives a strength and rigidity to the frame work which meets the exacting requirements of high-speed cutters, allowing them to obtain their maximum efficiency at the proper feeds and speeds. The doing away with the bolted connection between the head-stock and base allows these speeds and feeds to be used even with multiple broad shaving cutters fastened in the turret. Another advantage resulting from this one-piece design is the arrangement for driving mechanism it is possible to obtain with all the shafts and gearing beneath the spindle. This brings the driving shaft as close to the base of the machine as possible, and overcomes the vibration which is prevalent in the type drive belt mechanism. The spindle mechanism is transmitted through a gear mechanism giving thirty changes of speed, arranged in geometrical progression with a maximum ratio of 80 to 1. This insures ample driving power at the proper speeds for all work. The power is taken directly from the line shaft, through a constant-speed pulley with a friction control and reversing motion. All the changes of speed which may be obtained without stopping the counter-shaft are controlled by interlocking levers conveniently located, thereby preventing disastrous results through carelessness on the part of the operator. When desired, the lathe is equipped with motor drive. Any constant-speed motor may be used.

The lathe has a swing of 22 inches over the vees and 18 inches over the carriage. The spindle is bored to 3½ inches in diameter, and has a front bearing of 6⅝ inches in diameter. The turret, which has a width of 20 inches across the flats, has 3-inch holes for tools, and a maximum traverse of 52 inches from the face of the chuck. The lathe is fitted with an extra heavy three-jawed universal chuck. It weighs, complete, 8,000 pounds. It is built by the Steinle Turret Machine Company, Madison, Wis.

ROCKFORD SENSITIVE BENCH DRILL.

A sensitive bench drill, having a capacity of ¼-inch holes as a maximum, is manufactured by the Rockford Machine & Shuttle Co., Rockford, Ill. As will be noticed from the accompanying cut, one of the prominent features of this tool is the arrangement of the table, which can be swiveled around a horizontal axis, and can be set to any position and locked in any angle, thus greatly facilitating the drilling of holes at an angle to the locating or bottom surface of the piece in which the holes are drilled. The table has, of course, also a vertical adjustment for a considerable distance, as is plainly shown in the cut. The spindle, which is made of tool steel, is driven by means of a round belt running from a grooved pulley cast in one piece with the 2-step cone pulley constituting the main drive. The belt runs over idlers to the grooved pulley on the

spindle. The lower end of the spindle is fitted with a taper, and takes any 5/16-inch drill chuck. The counter-shaft has a 2-step cone pulley for a 1⅛-inch wide flat belt, and, of course, tight and loose pulleys, as usual. One feature worth mentioning is the adjustable angle plate shown in place on the table. This angle plate is intended for use when the table



Rockford Sensitive Bench Drill.

is tilted, to support the work on one side, when being drilled on an angle. This angle plate can be moved as desired, and locked at any place to the side of the table by means of the binding screw shown. The side of the table is provided with slots making it adaptable for work which can conveniently be clamped in this position. The size of the table is 8 x 8 inches, and its vertical adjustment is 5 inches. The greatest distance between the spindle and the table is 7¼ inches, and between the spindle and the frame 4½ inches. The lever feed of the spindle is 2¾ inches. The weight of the machine, including counter-shaft, is 83 pounds.

DEGEN'S ELLIPSOGRAPH.

The accompanying cuts show an interesting instrument for the drawing of ellipses and hyperbolas, recently patented by Mr. Julius Degen, of Trenton, N. J. The most interesting feature about this tool is its adaptability for drawing an

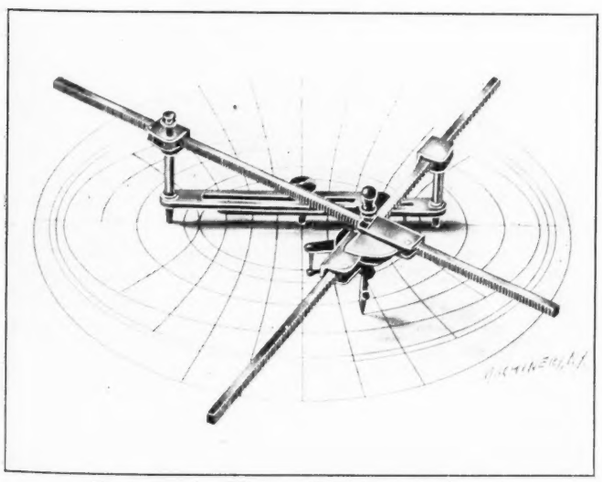


Fig. 1. Drawing Ellipses with the Degen Instrument.

ellipse as well as a hyperbola, the instrument being based on the principle that the sum of the distances from any point on an ellipse or a hyperbola to the two foci of the curve is constant. The instrument may also be used for drawing parabolas. In such a case an attachment not shown in any of the cuts takes the place of one of the posts shown at the foci. This attachment is permitted to slide along a T-square, and the pen or pencil then describes a parabola, so that, in fact, all the curves for conical sections may be drawn mathematically correct by this instrument.

The mechanical construction of the instrument is as follows: Two posts, provided with points, are connected by two slotted beams clamped together by a thumb screw. These slotted beams permit an adjustment of the distance between the two posts, the points of which, when the instrument is in use, are placed in the foci of the curve to be drawn. On the top of each of the posts is a stationary pinion, about the axis of which a head or casing swivels. Through this casing each of the two racks shown are passed, an easy sliding fit being permitted. The teeth of these racks are engaged with the tooth of the stationary pinion. These two racks cross each other, and engage at the crossing point with a traveling pinion, the vertical shaft of which is extended, and at the bottom of which a pencil or pen holder is attached. Around the traveling pinion there is a casing made as a guide for the racks. When the instrument is used, and the pen is moved by holding the knob at the upper end of the vertical shaft, the traveling pinion will revolve, moving inward on one rack exactly the same distance as it moves outward on the other, thereby causing the pen to move along a curve, every point on which is so located that the sum of the distances from any point of the curve to the foci is constant. When it is wanted to describe a hyperbola, the pen is

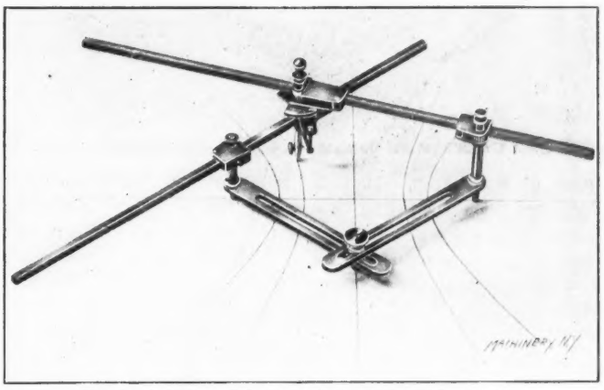


Fig. 2. Using the Ellipsograph for drawing Hyperbolas.

passed in the direction toward the center of the mechanism, and, as the same condition will obtain, the pen evidently will describe the desired curve. When the curves are drawn with ink, it is necessary that the pen always travels tangent to the curve being drawn, and the pen has to be guided around the vertical shaft continuously. A special mechanism is contained in this instrument for accomplishing this purpose. This mechanism is based on the fact that the tangent in each point to an ellipse or hyperbola bisects the angle between the two lines connecting the point in question with the foci of the curve. Each of the traveling heads or casings is provided with a flange in which is cut a spiral groove. Between the two flanges a steel plate swivels around the axis of the traveling pinion, having a slot running in a radial direction. A pin engaging both of the grooves previously referred to and also the slot in the plate between the two flanges, causes this plate to revolve around the vertical shaft whenever the instrument is put in motion. The steel plate has an extension at a point opposite the radial slot, to the end of which is riveted a small vertical pin engaging a hole at the end of a small horizontal arm, which is threaded into the head carrying the pen. By this arrangement a revolving motion is conferred upon the pen which keeps it constantly in the proper direction.

G. E. CENTRIFUGAL AIR COMPRESSORS.

After an extensive series of experiments, covering a number of years, the General Electric Co. is now producing a line of direct-connected centrifugal compressors for supplying air in large quantities at moderate pressures. They are built

for a number of capacities, and, for each capacity, in three sizes for the nominal pressure service of 0.88, 1.7, and 2.7 pounds per square inch, respectively, though they may be used at pressures greater or less than these by varying the speed at which they are run. They may also be arranged to act as "exhausters" for pressures within 3.25 pounds per square inch or 6.5 inches of mercury below atmospheric pressure. They are not adapted to low pressures, which field is satisfactorily filled by the ordinary fan blower. Their range of work covers more nearly that of the pressure blower, and therefore they are especially adapted for air blast for burning fuel, as in oil, gas or other furnaces.

Design.

This centrifugal compressor is a modified fan blower designed for high efficiency at pressures that are high for this

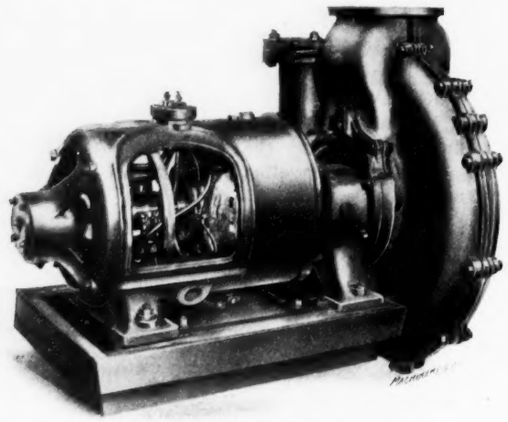


Fig. 1. Centrifugal Air Compressor driven by Direct-current Motor.

form of apparatus. It consists simply of an impeller of improved design rotating in a case. The impeller receives the air on both sides so as to avoid the end thrust. The general internal arrangement of the machine bears a close resemblance to that of the so-called turbine pump, so that the term "turbine compressor" or "turbine blower" has been aptly applied to this apparatus.

An important feature of the design is the fact that the compressor and its motive power are designed for each other,

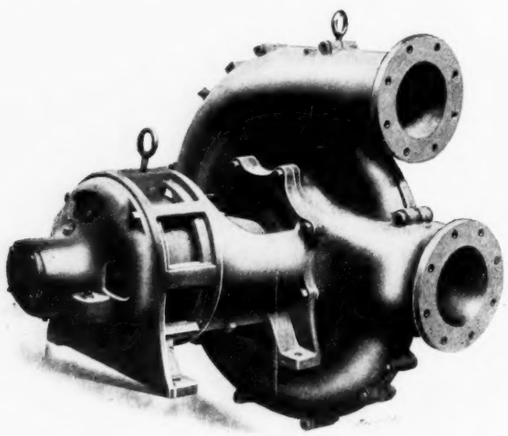


Fig. 2. Centrifugal Air Compressor driven by Alternating-current Motor.

and sold as a single unit. The compressor may be driven by a direct-current motor, an induction motor, or a non-condensing steam turbine. Under these conditions there is no belting, gearing or other transmitting device requiring attention and repair, the driving and driven members being mounted on a single shaft. On sizes below 50 horse-power, the frames of the two members are bolted together and stand on feet cast integrally with them. The larger sizes have a base or bed plate on which the frames, casings, and bearings are mounted.

Comparison with High-Pressure Fan and Positive Blowers.

This turbine compressor fills the field at present occupied by the high-pressure fan blower and the positive pressure blower. As compared with the ordinary fan blower design for the same service, it need only to be said that the efficiency is about one-third greater, while the new machine at the same time retains all the advantages of the older machine, such as its simplicity and the low cost of maintenance. There are also many points in which this rotary compressor shows superiority in comparing with the positive pressure blower. One of these is in the matter of pressure regulation

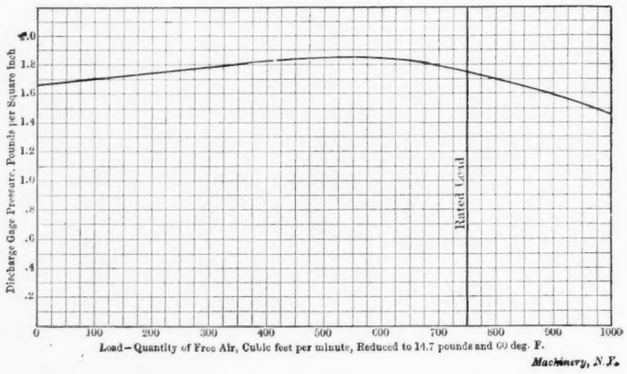


Fig. 3. Pressure Curve for Centrifugal Compressor, with Varying Load.

and consequent economy. With the positive pressure blower the machine normally receives a certain number of cubic feet of free air per minute which is forced into the main at the desired pressure. Ordinarily the means taken to regulate this pressure is the installation of a safety valve set at the required number of pounds per square inch. When the demand for air falls off, so that the blower is furnishing more than is needed, the pressure rises, and the excess escapes through the valve. All of this lost air involves waste of power. On the other hand, if the demand for air is somewhat in excess of the capacity of the machine the pressure drops below that desired for the use to which it is applied. As compared with this, the rotary compressor resembles the high-pressure fan blower in furnishing the air at a nearly constant pressure, practically independent of the amount furnished, within the capacity of the machine.

The characteristics of the apparatus in this respect would be appreciated by referring to Fig. 3, which shows the variation in pressure of one of these machines running at high speed, and with the outlet pipe throttled to various degrees. It will be seen that the variation in pressure is about 10 per cent within the full range from zero to the rated load, while

TABLE OF STANDARD SIZES, SINGLE STAGE CENTRIFUGAL COMPRESSORS FOR INDUSTRIAL AIR BLAST.

Drivers may be 220 volt, 60 cycle, 3 phase induction motors, either Form M or K, 125 or 250 volt D.C. motors or non-condensing steam turbines.

SERVICE.	Rated Pressure, pounds per sq. in.	Nominal Capacity, cubic feet Free Air per min.	Diameter of Discharge Pipe, inches.	Nominal H P.	Max. Press. D. C. or Turbine Drive, pounds per sq. in.
Foundry cupola or low press. air blast.	0.88	2600	12	20	1.5
	0 88	3600	16	30	1.5
	0.88	7000	20	50	1.25
	0.88	10000	28	75	1.25
Moderate pressure air blast.	1.7	750	8	11	3.7
	1.7	1400	10	20	3.7
	1.7	2000	12	30	3.7
	1.7	3600	16	50	2.5
High pressure air blast.	2.7	1200	8	30	4.2
	2.7	2400	12	50	4.2
	2.7	3400	14	75	3.0

the drop is not alarmingly great even with an overload of 33 per cent in cubic feet of free air furnished per minute. This constancy of pressure is, of course, obtained without regulating devices of any kind, being inherent in the design of the machine, the only requirement being that the speed of the impeller be kept constant.

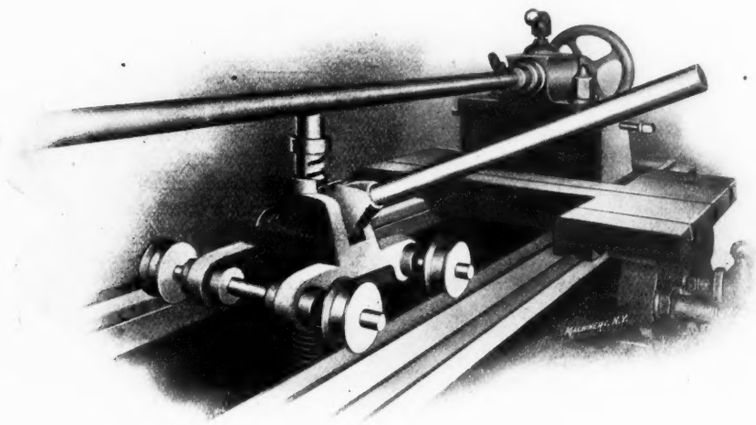
The turbine compressor also invites comparison with the positive blower on the score of rating and capacity. A positive machine is often rated from its mechanical displacement, no allowance being made for the heating of the air and the drop in pressure while entering the machine, not to mention the leakage around the moving parts. Actual tests have shown a loss of 50 per cent or more in capacity as measured by theoretical displacement in the case of a positive pressure blower. The builders of this device state that their centrifugal compressor will deliver as much air as a positive blower having a rating 33 per cent greater.

A further point in which this apparatus invites comparison is in its remarkable simplicity, there being only two moving parts, the rotor of the driver and the impeller of the compressor. There are no parts other than the two supporting bearings where wear can possibly occur. The bearings being self-oiling, the only attention which the machine requires is the renewal of oil in the reservoir at intervals. A number of machines have been in service for long periods without renewal or adjustment of any kind, and without attention, except the monthly renewal of oil.

Rating and Capacity.

As shown in the accompanying table, these compressors are built in standard sizes comprising a number of capacities for each of three pressures. They are made of such capacity as to permit the use of a single machine in a central location in a factory rather than installing a number of small blowers scattered in various places. Even the smallest machines listed are too large for small gas furnace installations, only comparatively large installations being provided for. For gas furnaces, an air blast capacity of about ten times the quantity of gas supplied is ordinarily required. For this work a machine rated at 1.7 pound per square inch should be used. For furnaces requiring a concentrated and positively directed jet, a machine rated at 2.7 pounds pressure should be used. The first four sizes on the list are especially adapted for supplying air blast and foundry cupolas.

The rated pressures given are at the beginning of the pipe line, and with the inlet full. Provision must be made for any pressure drop through the inlet supply pipe or in the main. All sizes are provided with inlet pipe flange connection, and the supply of air should be taken from a cool place out-of-doors to get the most efficient operation. The pressures given are for an air supply at a temperature of about 60 degrees. If the supply is hotter than this, or if the barometer is abnormally low, there will be a slight decrease of pressure. For an average case where the inlet air is heated somewhat, and where there is sufficient length of inlet and discharge pipe to give an appreciable drop, the three groups listed may be usually depended upon to give actual pressures in the mains at a distance from the machine of about 0.625, 1.25 and 2 pounds per square inch respectively. Extremely small pipes will give lower pressures. With direct-current motor drive, the rated pressure is merely nominal, and may be set by hand adjustment of the field rheostat up to the maximum value given.



Johnson & Bassett Shaft Straightener.

JOHNSON & BASSETT SHAFT STRAIGHTENER.

The straightening of shafts in the machine shop is often accompanied by more or less difficulty, because of the lack of proper appliances for doing this kind of work. Realizing that there is a demand for a good, and at the same time inexpensive, tool in this field, Johnson & Bassett, of Worcester, Mass., have placed upon the market the shaft straightener shown in the accompanying cut. This illustration shows what the makers call a No. 1 shaft straightener for use in lathes having from 14 to 24 inches swing. The cut shows the device applied to a 14-inch swing lathe, but its adjustable feature permits it to be used for the larger sizes as well. The capacity of the device is 1½-inch; that is, it will straighten shafts of any diameter up to this dimension. The wheels with which the device is provided can be run either on the vees or on the flat part of the bed, and are easily adapted to different sizes and makes of lathes. The device is not heavy, and can be transferred from one lathe to another with comparative ease. The advantages of this device are the simplicity and ease of application and adjustment, and the enormous leverage obtainable, due to the design. The device will undoubtedly be found a convenient and handy tool in many machine shops.

GAS OR OIL HEATED SODA KETTLE.

The Gray & Prior Machine Co., of Hartford, Conn., developed the soda kettle shown in the cut, for its own use. The peculiarity of this construction lies in the fact that it is heated by a Bunson gas, or a blue flame kerosene burner, instead of by the usual steam heated jacket, making the apparatus available for places where steam cannot be used, such as garages, and machine shops driven by motor or oil engines, where the steam heating plant is shut down during the summer. This provision makes the apparatus portable as well, so that it may be moved from place to place in the shop as necessity may require. The use of permanent steam pipe connections and steam trap for taking care of the drainage is also obviated. The burner used has an inner and an

Gray & Prior Soda Kettle.

outer ring flame, either or both of which may be used. The double flame needs to be used only when warming up the cold bath in the morning.

THE SCHMIDT DRIVING CHAIN.

The transmission chain herewith illustrated is manufactured by the Schmidt Drive Chain Co., 265 Broadway, N. Y. These chains are adapted for high speeds, silent action, and automatic compensation for lengthening of the links due to wear.

As may be seen from Fig. 1, this chain differs from others of this class in having the contact lugs formed midway of the links between the pivots. This gives a straight path for the links to follow, so that they are practically in simple tension and are not liable to bend and change their pitch under excessive or suddenly applied loads. For this reason the makers claim that for a given load the chain is lighter, giving less dead weight and a higher efficiency.

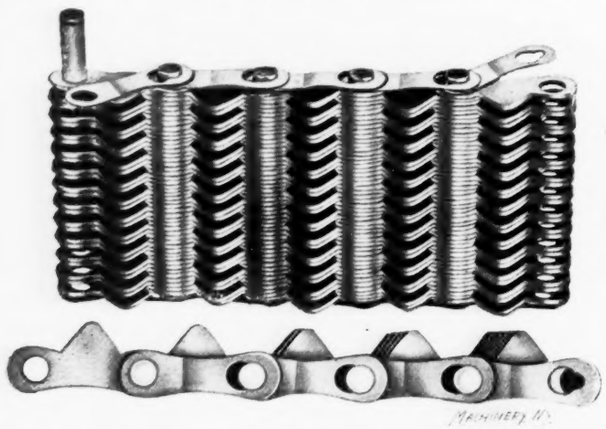
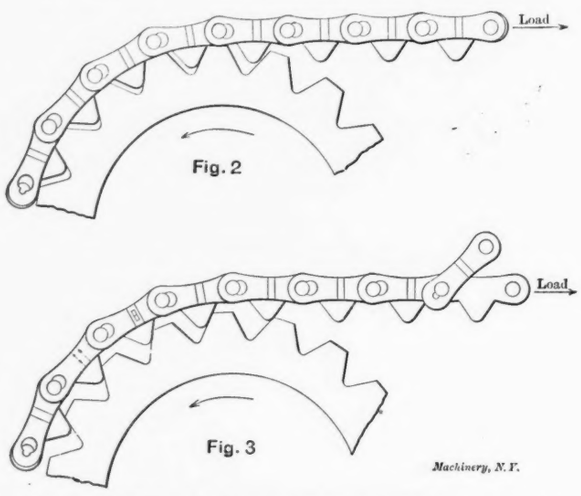


Fig. 1. The Schmidt Driving Chain.

Its action when new, and after elongation, may be compared by the diagrams shown in Figs. 2 and 3. As the pitch is elongated by wear, the beveled driving lugs on the links climb up the inclined faces of the teeth until they have found the proper pitch. For this reason the chain may be used until the pitch has elongated ½ inch per foot, or more, without the action losing its smoothness and accuracy. The teeth of the wheels have a considerable angle, and the lugs on the driving chains are so rounded as to prevent interference on sprockets having a small number of teeth. Very large gears may also be used, the number of teeth being limited only by the capacity of the cutting machine. Speed ratios as high as 20 to 1 are well within the capacity of this drive.

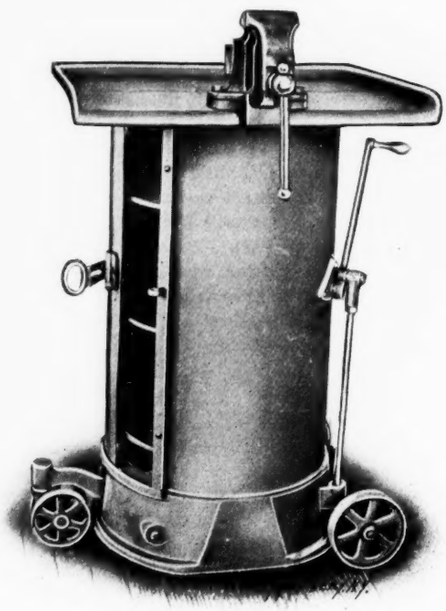


Condition of Chain when New, and when the Links have elongated One-half Inch per Foot due to Wear.

The construction of the chain is new. The outer end of each pin orifice in the links has the same radius as the pins. The links, therefore, always have full bearings on the pins, giving a large bearing surface, and doing away with the excessive wear in a new chain resulting from the use sometimes met with of a circular hole of larger diameter than the pin, which gives only a line bearing until the metal wears and forms a seat for it. The method of retaining the pins is novel and interesting. They are not riveted, but are held in place by means of special edge or retaining links, having a key-shape hole which passes over the end of the pin and enters a circular groove. These retaining links are offset and over-lap, and lock each other, as well as the pins, in place. One of them on each side of the chain, however, is made so that the chain may be disassembled for general overhauling, or for changing its length, without the use of tools.

PORTABLE VISE STAND.

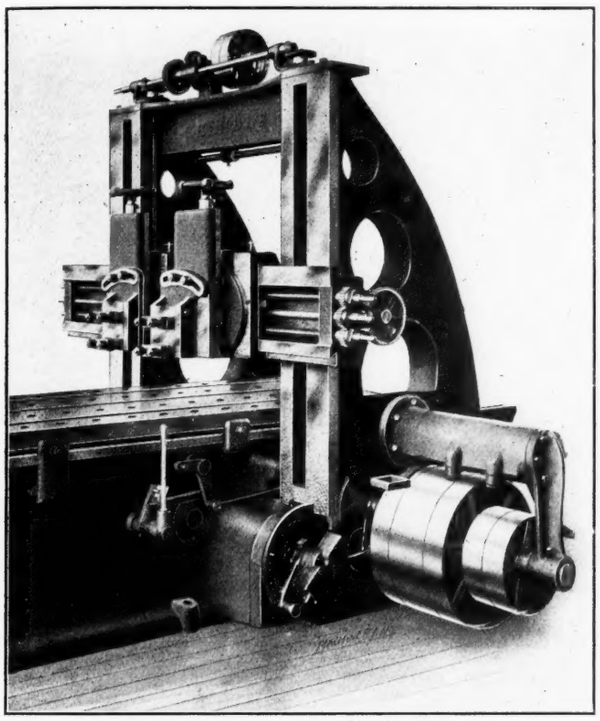
The portable vise stand, while it has not as yet become very much used, would undoubtedly fill a need, because in every shop there are a number of occasions arising almost daily where a portable work bench or vise stand, which can be easily moved from one place to another, is required. This need, having been recognized by the New Britain Machine Co., New Britain, Conn., has caused the design of the portable vise stand shown in the accompanying cut. This stand consists of a circular column of rolled boiler plate to which is fitted a cast-iron top so shaped that tools or work may be conveniently placed upon it without danger of falling off when moving the device from place to place. The bottom of the column rests on a cast iron base plate, being large enough to give ample floor support, and on the vise side far enough back from the working line so that, when standing by the vise, nothing is in the way of the workman's feet. The interior of the column is provided with three shelves, two of which are adjustable, intended for the storing of tools, the column having a sliding door. The door is so placed that the workman can easily open it and see the contents without moving from his working position. No truck is required for transporting this vise holder from one place to another. All that is necessary is to raise the self-locking handle to the position shown in the cut. This raises the stand from the floor and makes it bear on three wheels, one of which is mounted on a swivel. The stand can then be easily pushed across the floor, and when the desired point is reached, the lowering of the lever drops it upon its base, ready for use. These stands are equipped with a standard make of vise, but may be equipped with any vise desired, or even without the vise, if requested. The stand is built in two sizes: one in which the top tray is 20 x 26 inches, carrying a 3½-inch vise, and one with the top tray 24 x 32 inches, provided with a 5-inch vise. The height of the vise in both cases is 41 inches.



Portable Vise Stand.

IMPROVEMENTS IN THE CHANDLER PLANER.

The readers of MACHINERY are familiar with the Chandler planer, built by the Chandler Planer Co., Ayer, Mass., which was first described in our issue of July, 1904. As will be remembered, the most striking feature of this tool is the fact that it is driven by three belts from the counter-shaft—of which three, one is the regular forward motion belt, while the other two control the return, one of them giving a much higher speed than the other, and a much higher return than has been accomplished by any ordinary means. In operation, when the table is to be returned for the next stroke, the moderate speed backing belt is first thrown on, momentarily, thus quietly reversing the planer platen and the gears and pulleys which drive it; then the continued movement of the



Improved Features of the Chandler Planer.

belt shifter throws off this moderate speed, and shifts on the high-speed reverse, which rapidly returns the table to position for commencing a new cut. In shifting back to the cutting stroke again, the sequence is reversed. First the moderate speed belt is engaged, slowing down the platen until it is under control; then the forward motion belt is shifted onto the tight pulley. It will be seen that the moderate speed reverse belt stands midway in operation between the forward and fast reverse belts, and serves to make the transition between the two extremes quiet and controllable.

Other features of the tool are: the use of case-hardened and ground journals for the bearings of all high-speed shafts; a device by which the high-speed return can be disengaged and only the moderate speed used; a back-gear incorporated in the machine which can be used when a slow-cutting speed and high-belt ratio are required; and a feed mechanism which can be varied while the machine is in operation without requiring the clumsy and dangerous adjustment of moving parts. Besides these features there have been a number of recent improvements which will be understood by reading the following paragraphs, and referring to the accompanying cut.

The arrangement for throwing in or out of action the third or high-speed reversing belt has been much simplified. As now made, this is effected by simply manipulating a little tappet, pivoted to the lever operated by the platen dog on the left. When this is thrown up, the lever is carried clear over, and the third belt is brought into use. When this is turned down the platen dog can only shift the lever far enough to engage the moderate speed return.

The orthodox slotted plate cam for operating the belt shifter has been replaced by a set of circular cams, contained within the tubular arm by which the outboard bearing of the driving shaft is supported. The circular cams are much easier to machine than the plate variety, the mechanism is less exposed, and the mechanical connections with the reversing lever are much simpler, consisting merely of a gear on the cam shaft, meshing with a rack which is joined to the reversing lever by a connecting-rod.

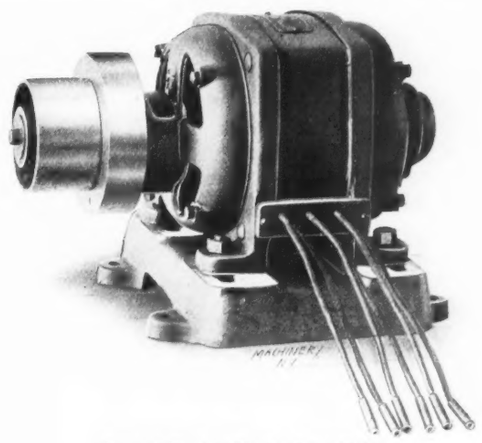
A friction feed-box has been designed which is not radically new in principle, but which is so well proportioned that it is able to work under severe conditions where a positive arrangement is ordinarily deemed necessary. This device is of the type in which the arresting of the friction member against the positive stop which limits its motion, serves to relieve the friction almost entirely. This design has been successfully applied to the severe service of operating heavy feeds on a 48 x 48-inch four-head planer, one feed-box driving all the heads, at the greatly increased cutting and return speeds of which the machine is capable.

Perhaps the neatest and yet the simplest of the new features is the means provided for altering the feeding from the commencement to the end of the stroke, or *vice versa*. As every planer hand knows, this is ordinarily done by shifting the crank-pin to the other end of the slot in the face of the feed-box. This is a ticklish job, especially if the planer is a large one with heavy feed mechanism, and more especially if the planer is in action. The method used on the Chandler planer is clearly shown in the cut. As usual, a slip pinion is used to connect the feed gear on the end of the cross-rail with the cross and vertical feed screws and shaft. The improvement consists simply in providing an extra stud above and below the central stud on which the pinion is ordinarily located. When it is placed on either of the other two studs, the train of pinions on the feed screws is rotated in the opposite direction, and the time of feeding is changed.

It might be mentioned that the planer shown is a special one, in which the back gear mechanism is omitted. For this reason the lever controlling it does not appear.

GENERAL ELECTRIC SINGLE-PHASE MOTOR FOR MACHINE DRIVING.

The General Electric Co. has placed on the market a single-phase motor for direct-connected machine driving, to fill the demand for a machine that would be rugged, compact, easy to operate and ample in capacity. As may be seen in the cut, these motors are similar in general appearance to the polyphase motors produced by the same makers. In the small sizes, such as that shown, up to and including 5 horse-power, a unique form of construction is used, known as the "riveted



General Electric Single-phase Motor.

frame," consisting of laminæ of soft iron, riveted between cast steel heads. In the larger sizes, 7½, 10, and 15 horse-power, a skeleton form of construction is used, differing slightly in detail, but possessing the same advantage as the riveted frame construction. Each of them provides for adequate ventilation, reduced weight, and compactness, all of which are attained without sacrificing other qualities in any respect. Strength and rigidity are insured by the liberal proportions of the bearings, shafts, etc. All the parts are jig made, allowing them to be replaced without requiring fitting.

The machine possesses all the simplicity of the polyphase

type, including the absence of rubbing contact and complicated internal mechanism. The rotor is of the well known high resistance "squirrel cage" type, while the stator windings are similar to those of the three-phase motor. By shifting the bearing head brackets, the motors are adapted to either floor, wall, or ceiling use.

Starting devices are provided which require a comparatively small starting current, varying from 2 to 3½ times the full load current throughout the whole line. The maximum starting current is required only on small motors in which a slightly different starting apparatus is provided, hence it does not assume abnormal proportions. When connected with lighting circuits, they can be thrown on without appreciably affecting the line, provided proper transforming capacity is installed, as usually provided for normal conditions. Clutch pulleys are provided with motors of 1½ horsepower size, or larger. These are so arranged that when the rotor has attained the given speed the friction band of the clutch, actuated by centrifugal force, engages the outer shell and the load is assumed. All the motors of the line can be directly connected to all kinds of machinery where moderate starting torque is required, as is the case with fans, blowers, generators, etc. With machinery required to be started under full load, as in the case of pumps, etc., clutch couplings are employed which are thrown in when full speed has been reached. Devices to start and stop the motor automatically can be supplied when regular attendance is not required, as when used in isolated pumping stations, refrigerating plants, etc.

The fact that these motors can be run from an ordinary alternating-current light circuit makes them easily adaptable to the needs of the small power user. Their compactness and small weight per horse-power, due to the riveted frame form of construction, makes them applicable to special cases where heavy or bulky machines could not be used.

NEWTON GEAR HOBBING MACHINE.

The Newton Machine Tool Works, Inc., Philadelphia, Pa., has had in operation in its own works for the past five years a machine for hobbing worm, spiral, and spur gears. This

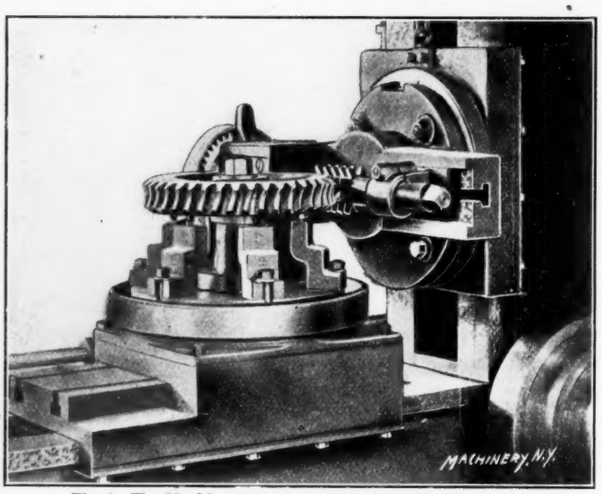


Fig. 1. The Machine arranged for Hobbing Worm-wheels.

has been so successful that another has recently been built for its own use, and the firm is prepared to build them for the trade as well.

The machine as arranged for cutting spur gears is shown in Fig. 2. The principle is well known to our readers and needs not to be minutely described. A hob, having teeth of the same shape as a rack, is used, set at an angle to the gear equal to the angle of the spiral on which its teeth are cut, so it can be fed straight down through the blank without interference. The hob and work are connected with each other by change gearing to rotate at the same ratio as that between the number of teeth in the gear and the number of threads on the hob. The machine being started up with the members

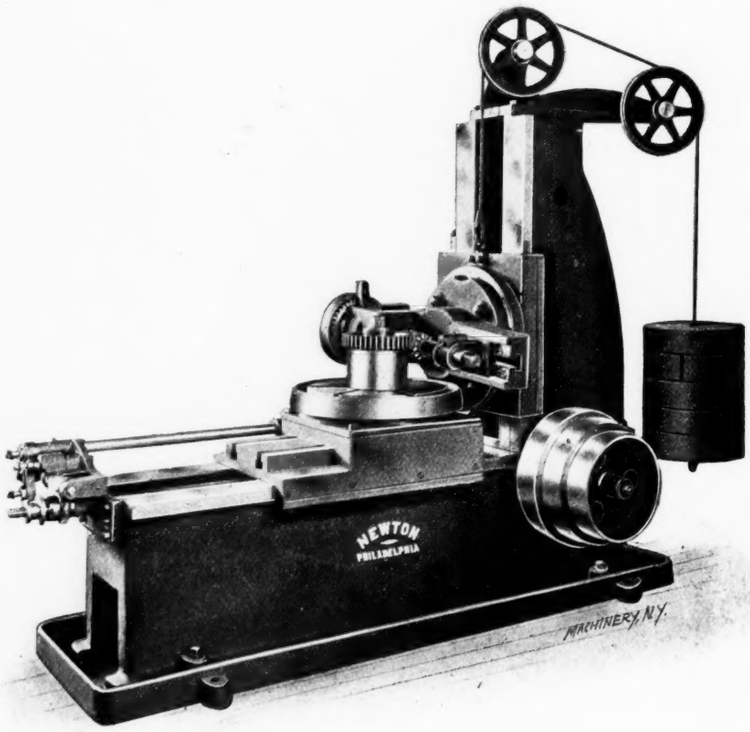


Fig. 2. Newton Gear Hobbing Machine at Work on a Spur Gear.

rotating at this ratio, and the hob being set to cut the proper depth, it is fed steadily down through the work, completing all the teeth at one feeding of the slide.

In Fig. 1 the machine is shown set up for hobbing worm gears; in this case the head is set, of course, to have the spindle horizontal. The blank and hob are geared together at the proper ratio as when cutting spur gears, but the work table with the blank is fed in toward the cutter until the proper depth has been reached, instead of having the cutter head fed down the face of the slide as in Fig. 2.

All the feed movements are by power, and are obtained by change gearing. The change gearing, for the feed of the table on the bed in hobbing worm-wheels, is located at the outer end of the bed, in the position indicated in Fig. 2, the feed movement for the screw being obtained from the splined shaft which drives the dividing worm. The dividing wheel of this machine is 20 inches in diameter, and the machine is of such dimensions as to take in blanks up to 40 inches in diameter. As will be noted, the head is counterbalanced. The machine has every appearance of strength and rigidity.

R. W. SPEED VARIATOR.

This device, made by the R. W. Speed Variator Co., Singer Building, New York City, is capable of transmitting power positively with a variable velocity with small gradations, a change being made without stopping the movement and without shock or jar. The way in which this is accomplished will be understood from a study of the accompanying cuts and description.

Fig. 3 shows a general view of the apparatus, while the line cuts Figs. 1 and 2 explain the mechanism. The driving member of the device is normally pinion *A*, Fig. 1, while cone *B* is the driven member. Obviously their functions may be reversed as occasion requires. The cone is formed with a

series of recesses, or "pits," as the builders call them, of suitable form to mesh accurately with the conoidal pin shape tooth on pinion *A*. These several rows of pits are arranged around the circumference of the cone at equal distances apart, and their number for each row varies in geometrical progression from one end to the other. One of the holes in each row is arranged in a straight line on the vertical plane of the axis of the cone, as shown in Fig. 1. This row of holes is formed in a tongue *C* adapted to have a limited sliding movement in a corresponding T-slot cut in the periphery of the cone, as shown in Fig. 2. This tongue furnishes means by which the pinion may be shifted from one row of pits to another without requiring it to be disconnected from the cone. If it is desired to move it to a larger diameter, for instance, as soon as the tooth in the pinion has engaged with the hole in the tongue, the latter is shifted to the left, carrying the pinion with it just far enough, and in time, for the next tooth to engage with the next larger row of holes on the cone. If it is desired to move it still further, the shifting is repeated as many times as may be required to bring the pinion to the desired point on the cone. The process may be reversed by shifting in the other direction, the tongue being moved a step to the right at each revolution, carrying the pinion with it from one row of pits to the next succeeding.

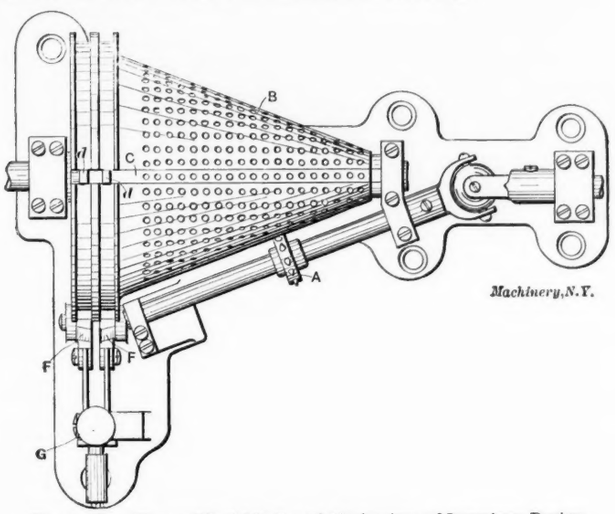


Fig. 1. Plan View of Variable Speed Mechanism of Ingenious Design.

Tongue *C* is moved automatically, the mechanism at the large end of the cone being provided for this purpose. Two lugs *d* are formed on the left-hand end of the tongue. At

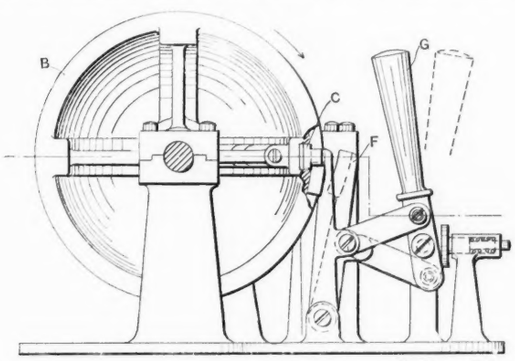


Fig. 2. End View of Variable Speed Device, showing one Cam Thrown in for Shifting.

the larger periphery of the cone, two grooves are turned and lugs *d* normally stand midway on these grooves. This normal position is maintained by spring connections, which return the tongue to this position whenever it has been displaced longitudinally. Two cams *F* are pivoted at the base of the device, and are connected with handle *G* in such a way that either of them may be thrown into the corresponding groove, it being impossible for both to be thrown at the same time. When one of these cams is thrown in, its point enters the space between the lug *d* and the flange, forcing it outward against the pressure of the constraining spring, and carrying

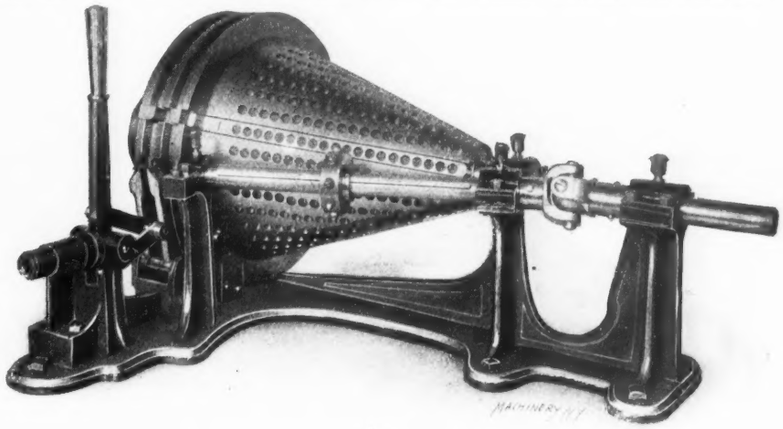


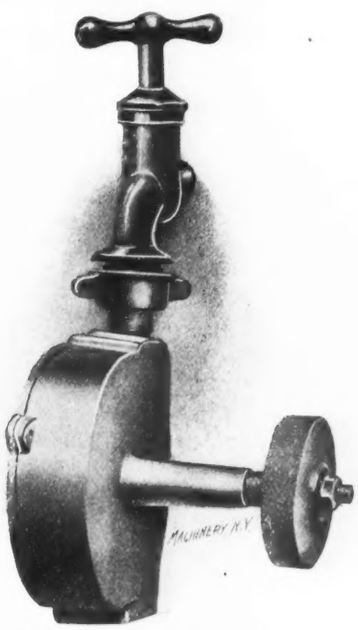
Fig. 3. General Appearance of Variable Speed Mechanism.

the pinion with it to a new row of holes. After the cone has turned a short distance, the lug passes the cam and drops back into the neutral position. If lever *G* is still held in the same position, the cam will act as before, on the next revolution of the cone, shifting the pinion another step to a new row of pits. This action will continue as long as the lever is operated, or until the last step on the cone has been reached, in which case an automatic mechanism throws the cam out against the force applied to it by the operator. When the handle is moved in the opposite direction, the reverse motion takes place, and the pinion is moved down step by step toward the opposite end.

This device finds its application as a counter-shaft mechanism in driving machinery of various kinds; in textile machinery where slight variations of speed are required, as in driving rolls on which cloth is wound; and in feed change mechanisms and other devices of a similar nature.

LIPPINCOTT WATER MOTOR GRINDER.

In the accompanying illustration is shown a water motor mounted directly on a faucet, and provided with a small



Lippincott Water Motor Grinder.

emery wheel. This motor can be used with advantage where the water pressure is 20 pounds and over, and is very service-

able for grinding all kinds of small tools. At 20 pounds pressure a motor makes 4,000 revolutions per minute, and at 50 pounds pressure, which is, perhaps, about the average water supply pressure, the speed averages 5,000 revolutions. These motors are very handy both in machine shops and elsewhere, an advantage being that belting and counter-shafts are done away with, and that the speed and power may be instantly regulated by the admission of water through the faucet. The stream of water issuing from the motor is made useful in cooling the tools. The motor may be attached to any faucet in less than a minute, and emery wheels may be interchanged in a very short time. A suitable rest may be provided to give the proper angle for the grinding of twist drills. This water motor is manufactured by the Lippincott Motor Grinder Co., Newark, N. J.

WILLIAMS DROP-FORGED PLANER CLAMP.

The half-tone herewith shows a stiff, substantial, drop-forged clamp intended to be used on the planer or milling machine, or, in general, on any machine tool where clamps of this description may be required. The advantage of clamps manufactured in this manner is the possibility of having an assorted and uniform supply of clamping devices, and as such these clamps are likely to prove valuable additions to the machine shop equipment. These clamps are made from a

Williams Drop-forged Planer Clamp.

strong, tough grade of steel, and are submitted to a case-hardening process after forging, so as to enable them to stand hard usage. This clamping device is made by J. H. Williams & Co., Brooklyn, N. Y., and may be had in three sizes ranging from 4 to 8 inches in length, and 1⅝ to 2⅛ inches width at the center, the thickness varying from ¾ to 1⅛ inch. The oval hole in the clamp permits of considerable adjustment, the length of the slot varying from 1¾ to 2 13/16 inches, according to size. The width of the slot is from 11/16 to 13/16 inch.

BEVEL GEAR CUTTING ATTACHMENT FOR AUTOMATIC SPUR GEAR CUTTER.

E. J. Flather Mfg. Co., of Nashua, N. H., has recently designed an attachment which may be applied to its automatic spur gear cutting machines, and used for cutting bevel gears. As may be seen in the cuts, the attachment is bolted to the front face of the work spindle head. The attachment comprises a body on which is mounted a head carrying a supplementary spindle. This supplementary spindle may be adjusted at any angle from the vertical to the horizontal. It is connected with the work spindle for indexing the blank by means of a bevel gear on its inner end meshing with a second bevel gear mounted on the axis by which the supplementary head is adjusted for the required angle. This latter bevel gear, in turn, meshes with a third attached to the work spindle. It will be seen that with this provision the index wheel of the machine controls the supplementary spindle on which the bevel gear is mounted at whatever angle the supplementary head may be set. The bevel gears of this connection are carefully cut, and are provided with adjustment for reducing the back lash to zero.

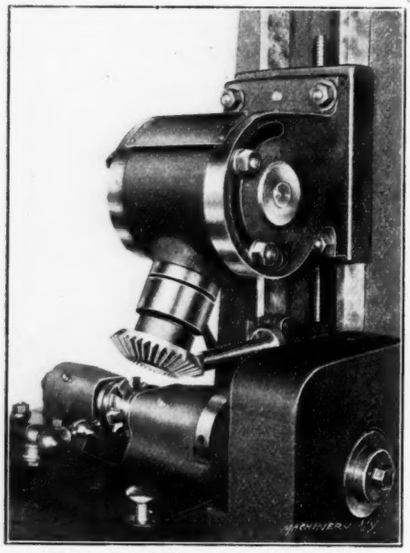


Fig. 1. Detail View of the Attachment.

In cutting bevel gears with this attachment, the head is set to the cutting angle, and the cutter set central as usual, if it is thought best to take a central cut through the teeth previous to the finishing cuts. For the finishing or side cuts, the blank is rotated the proper amount by the provision made for this in the mounting of the index worm, while the cutter is shifted sideways to correspond with the rolling movement

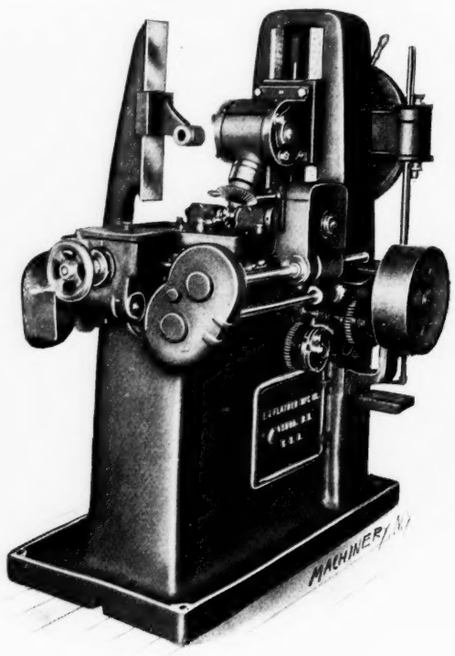


Fig. 2. Bevel Gear Cutting Attachment applied to an Automatic Spur Gear Cutter.

by the regular sidewise adjustment provided with the machine. This latter adjustment is effected by a spanner wrench acting on the nut encircling the spindle sleeve, seated in a recess on the inboard cutter spindle bearing as shown in the half-tones. This attachment has proved to be perfectly satisfactory with the small and medium size gears which constitute the great portion of the work done on a machine of this size.

DIAL GAGES FOR ACCURATE MEASUREMENTS.

The accompanying half-tones illustrate a number of interesting dial gages made by B. C. Ames & Co., of Waltham, Mass., who make a specialty of fine watch and clock making machinery. The gage shown in Fig. 1 is termed a jaw gage, and it is intended for the measuring of diameters of small

Fig. 1. Jaw Gage for Accurate Measurements.

work, particularly those occurring in watch or clock manufacturing, or for any small and fine measurements like wire, paper, sheet metal, etc., where extreme accuracy is required. The device works on the rack and pinion principle, and the reading is made to 0.001 inch, although, of course, much

finer sub-divisions can be estimated between the comparatively large graduations of the dial. The capacity of this gage is 0.2 inch. The dial is provided with two hands, the long hand indicating the number of thousandths, while the small hand shows the number of revolutions that have been made by the large indicating hand. The case enclosing this gage is made particularly strong so as to be able to withstand the hard usage of a machine shop without injuring the mechanism contained, and is provided with feet to stand on the bench.

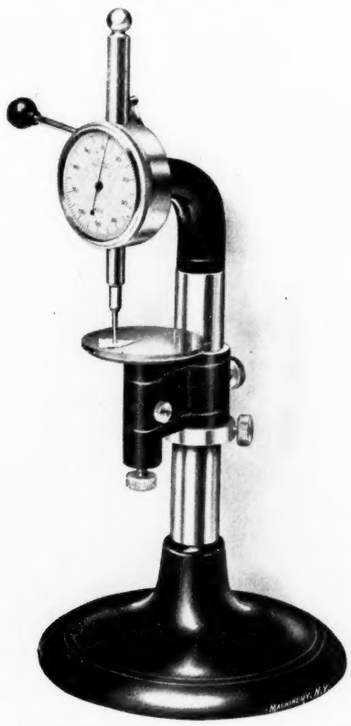


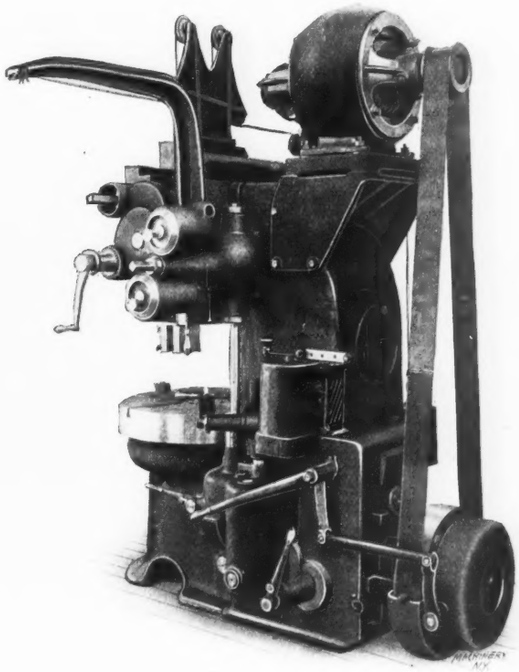
Fig. 2. Upright Dial Gage of the Rack and Pinion Type.

In Fig. 2 is shown what is called an upright fine gage, which is also graduated to 0.001 inch and made on the rack and pinion principle. The platen or table of this gage is made to turn around its center, and is provided with a fine adjusting screw used for bringing the platen up to such a height that the hand of the gage will indicate at zero when the end of the measuring rod rests against the platen itself, or against the surface of any standard gage with which it may be desired to compare when testing work. The bracket carrying the platen is fitted to the upright portion of the stand as shown, which gives a long range to the gage. In Fig. 3 is shown a gage head which is of the same construction as that used in the upright gages. This head is provided with a back suitable for attaching to it any kind of mounting. The many varied uses to which this gage may be applied will readily suggest themselves to the toolmaker who is required to make accurate measurements. The gage can also be used as a center indicator, snap gage or limit gage. It is well adapted for being applied to fine measuring devices for the lead of screw threads, and for gage testing.

Fig. 3. Dial Gage Head.

THE GISHOLT BORING AND TURNING MILL.

The boring and turning mill illustrated in the accompanying cut is one of the latest products of the Gisholt Machine Co., 1316 Washington Ave., Madison, Wis. The machine is motor driven, a 5-horsepower variable speed motor being provided, the speeds ranging from 400 to 1,600 revolutions per minute. A single friction pulley is substituted for the three-step cone pulley ordinarily used on belt driven machines, and the machine is gear driven. The friction pulley is controlled by a lever, as shown, and the table is under absolute control of the operator, and can be conveniently moved any fractional part of a revolution. The machine is provided with eight feeds, and, on account of its friction device, the danger of stripping the gears through careless handling is reduced to a minimum. An automatic feed tripping device permits any of the feeds to be positively stopped at any predetermined point. The dials for the feed trip may be plainly seen in the cut at the end of the cross rail. The tripping arrangement will also throw out the feed at either end of the traverse movement whether the dials are set or not. All feed screws are provided with index dials graduated to 0.001 inch. The machine is furnished with either a plain table or chuck, and the extreme swing of the machine is 36½ inches. The motor of the machine, being mounted as shown, does not require any additional floor space, and the machine is fully self-contained.



Gisholt Boring and Turning Mill.

ONE-BELT REVERSIBLE COUNTER-SHAFT.

A new counter-shaft has been brought out by the Smith Counter-shaft Co. of Boston, Mass. This counter-shaft gives two forward and one reverse speed, using but one belt from the line-shaft to the counter-shaft. The half-tone, Fig. 1, and the line cut, Fig. 2, show the general appearance and construction of this counter-shaft. From Fig. 2 it will be seen that the device consists of a pulley with a spur gear attached to the hub, an internal gear connected with frictions *A* and *B*, and a three-arm spider carrying intermediate pinions meshing with the spur gear and the internal gear. The three-arm spider is connected with the frictions *C* and *D*. The

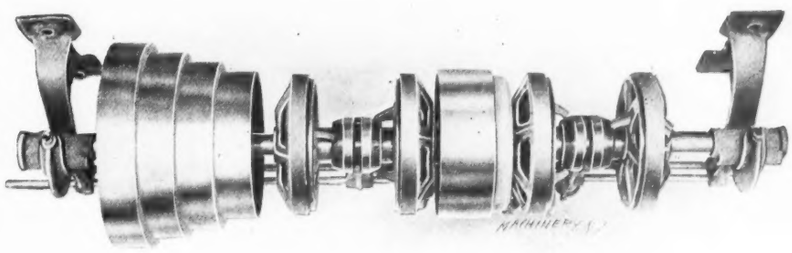


Fig. 1. Smith One-belt Reversible Counter-shaft.

operation of the device is as follows: Friction *C*, when engaged, keys the spider to the shaft, while friction *D*, when engaged, holds the spider stationary, preventing it from rotating; friction *B* keys the internal gear to the shaft, and *A* holds it stationary. The female members of frictions *C* and *B* are keyed to the shaft, and those of *A* and *D* are fastened to the over-head beams, preventing rotation. The clutch operating arrangement acts as follows. When the shifting rod is moved to the left frictions *C* and *A* are engaged. This gives a slow forward speed. When the shifting rod is thrown to the right, frictions *B* and *D* become engaged, which gives

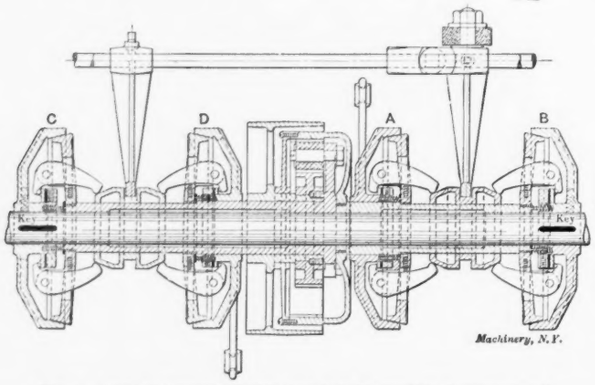


Fig. 2. Section through Smith One-belt Reversible Counter-shaft.

the reverse drive, the three-arm spider being held stationary and the internal gear being keyed to the shaft. A high forward speed is obtained when the shifting rod is first thrown to the left, and then, at the same time gripping a latch lever operating a disengaging mechanism, is again thrown to the right. This causes a connection between the pulley itself and the shaft, thereby driving the shaft with the same speed as the pulley. In this case frictions *B* and *C* are both engaged, the mechanism permitting the engaging of friction *B* without disengaging friction *C*. A neutral position of the shifting rod will stop the counter-shaft regardless of which frictions have been engaged.

COMBINATION FOOT AND POWER PRESS.

The machine shown herewith, made by the Automatic Specialty Company, Cincinnati, Ohio, is constructed with a view of supplying the demand for a small, quick-acting punch press for the manufacture of light sheet metal and brass goods. It has the advantage of being useful in cases where power is not available, as well as in shops where it is. This makes it adapted to the use of tinners, stove and cornice workers, and other manufactories, where foot power is the only motive power in use. As a belt driven fly wheel press, the makers believe that it will compare favorably with any other machine in the market of 50 per cent greater weight, since especial care has been taken to distribute the metal so as to give the greatest strength and power obtainable. The wearing surface and bearings are simply constructed and accurately

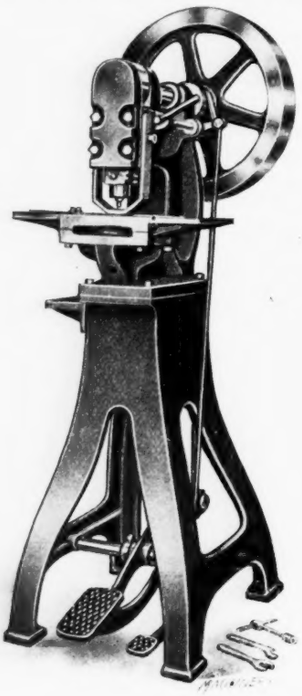


Fig. 1. Automatic Specialty Co.'s Combination Foot and Power Press.

fitted, and are made of suitable materials, and of such proportions as to give durability under the severest service to which a press of this size and character should be subjected. The ram is fitted with an adjustable gib to take up the wear, though this would be reduced to a minimum owing to the large area of bearing surface provided. The automatic clutch may be operated either by the hand lever shown at the right of the spindle, or by the right-hand foot lever. The fly-wheel is bronze bushed, and can readily be replaced at small cost.

When being used as a foot press, the treadle beneath the machine is connected with a crank-pin on the fly-wheel which is revolved by the foot of the operator in this way. For light work, a working stroke can be made at every revolution of the fly-wheel by this method. For heavy work, beyond the range of the usual foot press, the fly-wheel may be speeded up for several revolutions and the automatic clutch thrown in, as when working with power, when the stored momentum will punch a hole well up to the full capacity of the machine.

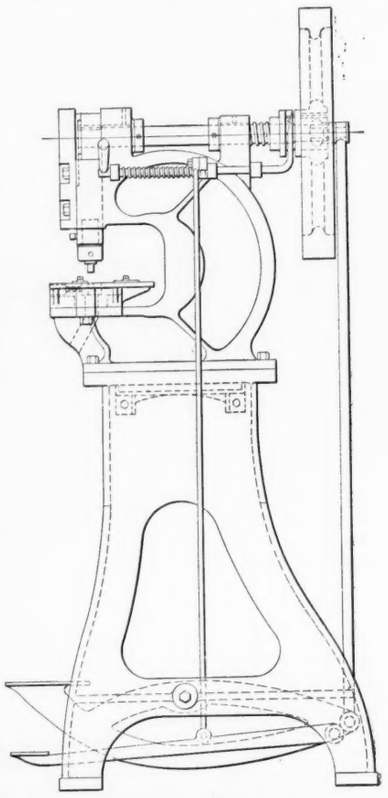


Fig. 2 Design of Combination Foot and Power Press.

The machine, as shown, is regularly provided with a front and side gage on the bolster plate for guiding the stock to the punch when duplicate pieces are wanted. A stripper, as shown, is fastened to the sides of the column. The equipment includes a set of three wrenches and a choice of three punches of standard sizes ranging from ⅛ to ¾ inch. The full capacity of the machine is for holes up to ⅞ inch in diameter through ⅛ inch brass or soft iron. The distance from the center of the slide to the back of the throat is 5¾ inches; from the bed to the bottom of the slide when up, 4½ inches. The fly-wheel, which is 19 inches in diameter, weighs 105 pounds and should run from 175 to 200 revolutions per minute. The weight of the machine is 500 pounds.

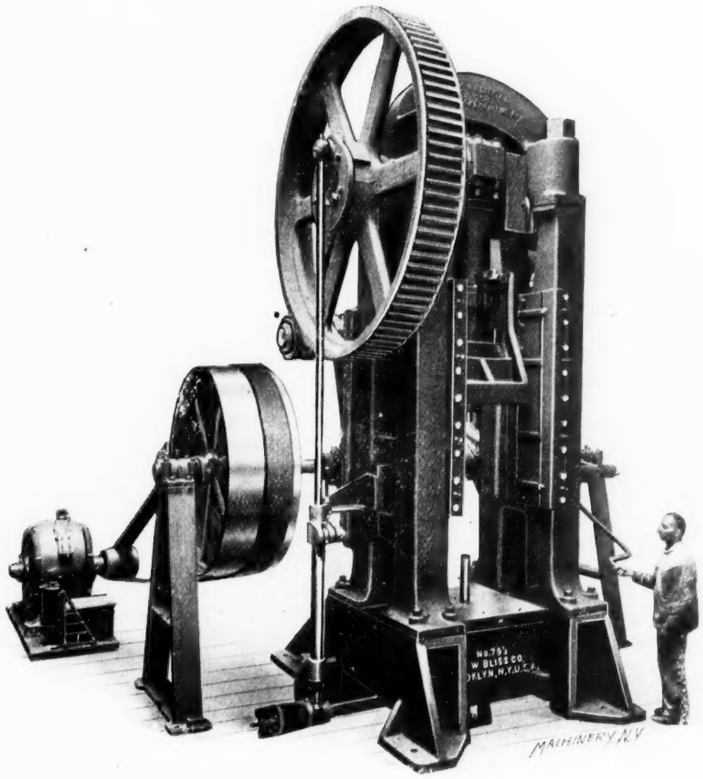
BLISS SINGLE CRANK PRESS OF UNUSUAL SIZE.

This press, built by the E. W. Bliss Co., 5 Adams Street, Brooklyn, N. Y., is stated by its builders to be the largest machine of this type the company has ever built, if not the largest ever built by any one. It can be used for a variety of purposes, such as heavy blanking, trimming and shearing, and it is in addition provided with a long enough stroke (24 inches) to make it especially suitable for the work of drawing cold from heavy sheet steel, such articles as automobile pumps, cream separator bowls and deep drawn seamless shells. It can be applied to such of this work as does not require the blank holder that is essential in the manufacture of parts drawn from thin sheet metal. With the thicker metals for which the press is intended, no blank holder with attendant toggle or cam action is required or provided.

The machine is provided with a base of suitable foundation area for a machine of its size. Double frame columns on each side connect this bed with the arched crown piece on the top, which binds them together and furnishes the bearing

for the crank-shaft. The crown piece is solid with the bearing box, and the caps are so formed that the crank-shaft can be removed or replaced in its working position without disturbing the crown piece.

Four vertical tie rods, each six inches in diameter, pass



Bliss Large Size Single CrankPress.

through the frame columns connecting the bed and the crown piece, and receive all the tensile stress due to the pressure exerted by the machine, thus relieving the frame columns of all working tension. The frame columns themselves are of cored section, of ample dimensions to impart rigidity to the entire structure, and to support the bearings of the back gearing and driving shafts. The bed is provided with a cored opening 12 inches in diameter, and a bored recess 16 inches in diameter, into which a heavy plate may be inserted when the work is such that it is preferable to dispense with the opening in the bed.

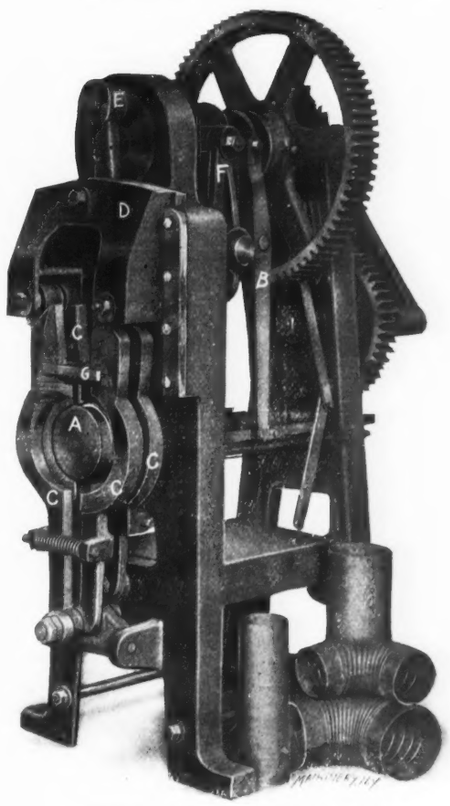
The driving and intermediate gears and pinions are made of steel, the main gear and pinions having specially designed short teeth shrouded, thus attaining unusual strength without any undesirable enlargement of the pitch. The press is started and stopped by a single hand lever, operating an unusually powerful friction clutch and brake. The press can be readily stopped at any position of its stroke up or down. The main shaft is of high carbon open-hearth steel. The Pitman is of cast steel, provided with a 6-inch forged steel adjusting screw, whose adjustment is effected by means of a ratchet, as may be seen in the cut. A powerful knock-out is provided, operated by a crank-pin in the hub of the main driving gear as shown. This may be easily adjusted for various strokes, or may be rendered inoperative when its use is not required. The parts of the knock-out beneath the bed may be readily removed to make way for work which it may be desired to pass through the bed instead of being extracted from above.

The following dimensions will serve to give an idea of the size and capacity of this machine. Stroke of slide, 24 inches; adjustment of slide, 8 inches; depth below floor line, 30 inches; total height above floor line, 16 feet 7 inches. The fly-wheel is 62 inches in diameter, 10½ inches face, and weighs 2,500 pounds. The gearing ratio is 58 to 1. The total weight of the machine is 75,000 pounds.

MACHINE FOR FORMING RIBBED ELBOWS IN STOVE PIPING, ETC.

This tool, built by the Toledo Machine & Tool Co., Toledo, Ohio, is an example of the ingenious special machinery, designed from time to time to perform seemingly complicated operations that occur in large-scale manufacturing. The operation to which this machine has been applied is the manufacturing of ribbed elbows in sheet metal piping. The ribbed elbow was invented to do away with the cost of the operation of cutting out and assembling segments of which the ordinary curved pipe angle was constructed. This further improvement in the method of making it should result in a further cheapening of the cost of this article. As has been stated, and as may be seen from the cut, the machine is highly specialized. The work is done over a "horn," as it is technically called in press work. This is seen at *A*. It is supported from the rear of the machine by a backwardly-extending shank. On this shank slides a work-holding chuck by which the tube to be pressed is grasped by the turning of a small hand-wheel. The tube need only be rolled to the proper diameter. When the machine is started up, a cam on the counter-shaft operates lever *B*, which by a ratchet movement advances the chuck and the work step by step for each rib formed. At the conclusion of the required number of ribs, an automatic stop arrests the movement of the machine.

In forming ribs, the first movement after the work has been fed to a new position on the horn is the closing down over it of the 4-hinged clamping arms *C*. These are closed by an engagement with the cam surface at their upper ends on rollers carried in hood *D*, which locate the material downward by the motion of the crank *E*. The work being thus firmly held to the horn, an expander, seated in a recess in the upper surface of that member is pressed outward,



Toledo Press for forming Ribbed Elbows.

and a ridge formed in the upper side of the work. When this has been done, lever *F*, actuated by a cam on the main crank-

shaft, through its connection with strap *G*, draws in toward the frame of the machine the two outer of the four clamping arms *C*, these being hinged at the bottom for this purpose. By this means the rib previously formed is pressed tightly together between the faces of the four arms, the expander having meanwhile withdrawn into its seat again. The continued movement of the crank-shaft opens out the clamping arms, feeds forward the stock another step, continues the previous operations, and forms a new rib. These ribs being formed to full depth on one side of the piping only, a curve is formed in the work. The line of this curvature is regulated by the number of ribs pressed.

It will be seen that the operation of the machine is practically automatic. The work is ejected from the holder at the completion of the required number of ribs, and the parts returned to position for commencing the new operation, the only attention on the part of the operator being the clamping in of new cylinders. The work is formed at the rate of 60 or 75 ribs per minute, making it possible to form approximately 200 elbows per hour. The labor cost of making the elbows is still further reduced from the fact that it is not necessary to rivet or close the seams prior to this operation.

ZEH & HAHNEMANN ARMATURE NOTCHING MACHINE.

Zeh & Hahnemann of Newark, N. J., have recently completed the design of a line of armature disk and segment making machinery, of which we show one example here. This machine, known as the No. 3, is intended primarily for notching disks of moderate size, from 3½ to 30 inches in diameter. As may be seen, it is built along the general lines of the ordinary punch press, but with the bed and work-holding mechanisms specialized for the work it has to do. The bed is in the form of a bracket clamped to the face of the column, and adjustable for height to suit the tools to be used. The thrust of the cut is taken by a screw jack directly in line with the compressive strain. This jack serves also as a means of adjusting the bracket vertically. On two arms projecting forward from the bracket is supported the work-holding and indexing mechanism. The work is clamped between disks by the operation of the cam lever shown at the top of the clamping arm. The lower disk is connected with the vertical spindle whose lower end carries the notched indexing wheel. A slotted disk on the end of the crank-shaft operates through the bell crank and connecting-rods shown, an arm swinging about the axis of the work spindle and carrying a dog by means of which the disk is indexed. A cam on the crank-shaft just alongside the slotted disk, by similar connecting mechanism, operates the lever by which the index wheel is locked and released for each operation. The work is securely locked before the punch enters the material. The automatic stop on the index ring is adjusted to throw out the clutch at the completion of the work. All the reciprocating parts of the feed mechanism are light and are given a motion which starts and stops them gradually, thus insuring smooth action at all speeds. The adjustments for different diameters and different numbers of notches are easily made. If it is desired to hold the work in some other way, the clamping arm may be readily removed. This machine weighs complete about 1,600 pounds.

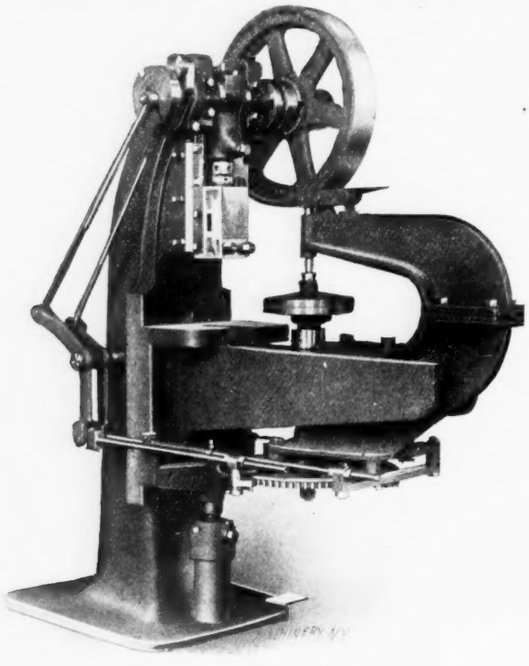


Fig. 1. Zeh & Hahnemann Armature Notching Machine.

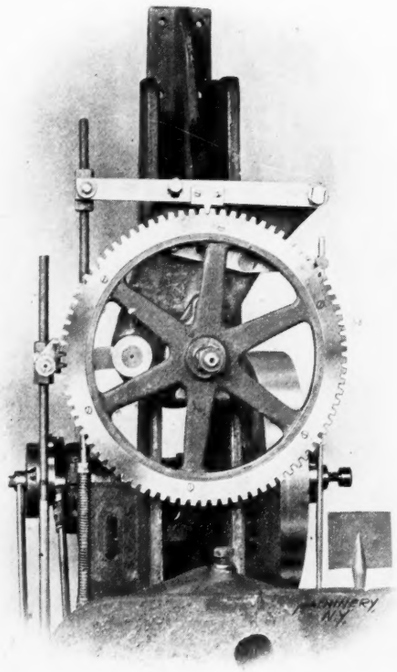


Fig. 2. View of Indexing Mechanism, Zeh & Hahnemann Armature Notching Machine.

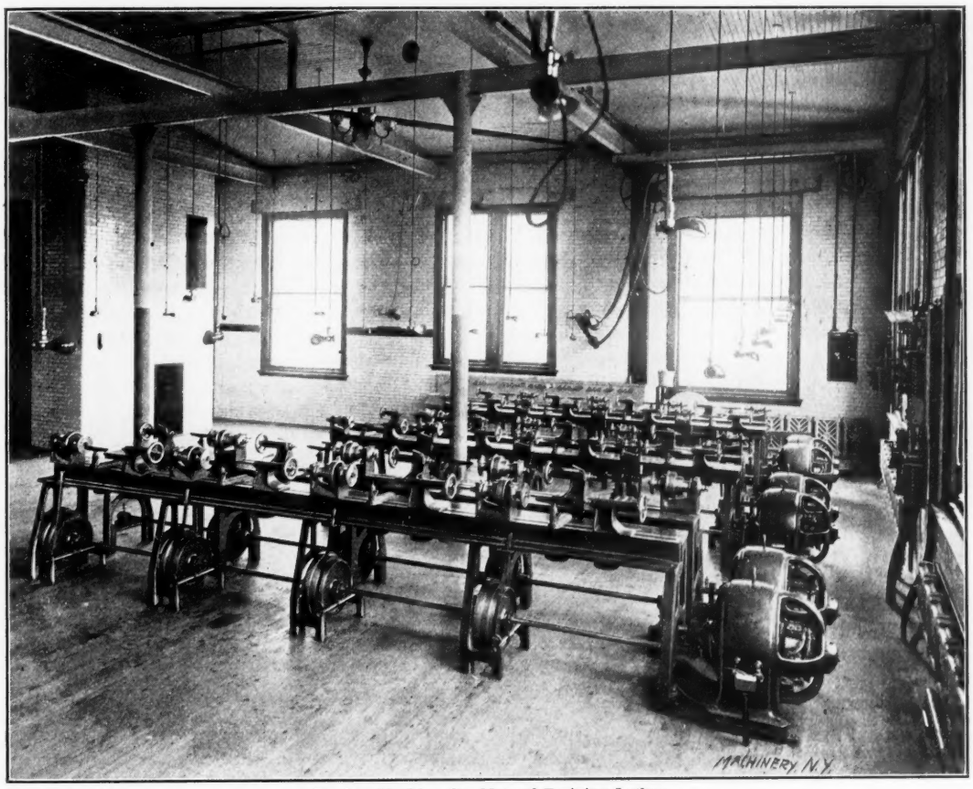
FISCHER INSTALLATION OF WOOD TURNING LATHES.

The accompanying half-tone illustrates a rather novel installation of machine tools containing many interesting features. The tools shown are wood turning lathes, but of course the principle involved could be applied in every case of light turning. As seen from the cut, there are four individual head-stocks and tail-stocks mounted on one long bed, the four units all being driven by one motor at the end of the bed. The motor drives the shaft shown under the lathe beds, which may properly be termed the line-shaft. At the left of the operator on each machine there is a lever connected to a clutch which engages a friction drive by means of which the power from the motor is transferred to the three-step cone pulleys shown. This arrangement permits each operator to throw in or out his power independently, and makes his machine a complete unit. Installations of this kind are especially intended for use in trade schools and manual training schools, the arrangement involving a great saving, as it does away with all overhead belting and ordinary counter-shafts. It is evident, however, that the principle involved, as well as the identical arrangement here shown, would be of value even for other installations than trade schools. The half-tone shows an installation made by the Fischer Machine Co., of Philadelphia, Pa., in the new Southern Manual Training School of Philadelphia. The view given in the photograph shows 24 lathes in six batteries of four lathes each. At the same school 24 more lathes working on the same principle have been installed in the floor above. The length of each lathe bed is 17 feet for 12-inch lathes, and 14 feet for 10-inch lathes.

NEWTON COMBINATION COLD SAW CUTTING-OFF MACHINE.

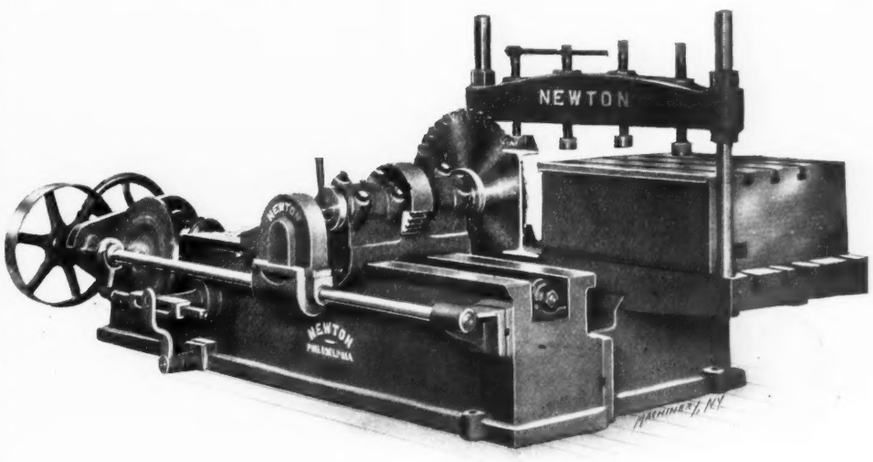
In the cut herewith is shown a cutting-off machine built by the Newton Machine Tool Works, Inc., Philadelphia, Pa., known as its No. 2 Combination Cold Saw Cutting-off machine. This machine is fitted with an inserted tooth saw, and is specially adapted for cutting I-beams on a square or miter cut.

The table of this machine is adjustable for convenience of setting the work, and it is so designed that the top of the table can be easily removed, as indicated in the cut, and the machine can be fitted with a cutter head and used as a rotary planer, this provision being in particular desirable in small bridge building and structural shops. The carriage has a continuous automatic feed with quick return by power.



Fischer Machine Co. Manual Training Lathes.

The inserted teeth of the saw are of different widths, and one wide and one narrow tooth is inserted alternately. They are set very close together and are held in place by means of an inverted wedge and a set-screw. The drive of the machine is through spur gearing, driving a hardened steel worm working with a phosphor bronze worm-wheel. In the cut the saw is shown cutting through a 15-inch I-beam, the lineal feed in this case being 1¼ inch per minute. This feed was obtained without any strain on either the work or the blade, and without any "jump" when the saw passed from the heavy to the light cut. This steadiness is due to the rugged construction of the spindle drive and feed mechanism with which the machine is provided.



Newton Combination Cold Saw Cutting-off Machine.

This cutting-off machine has a capacity for round stock up to 7 inches in diameter and for I-beams placed in a vertical position up to 15 inches high. Any section 7 inches high by 24 inches long may be cut by being placed on the side, so that 24-inch I-beams may be cut by laying them flat on the table. The weight of the machine is about 8,000 pounds.

ANNUAL MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The fifty-fourth annual meeting of the American Society of Mechanical Engineers will be held in the Engineering Societies Building at 29 West 39th Street, New York, December 3-6, 1907.

Symposiums on foundry practice, giving the experiences of prominent men in that work, have been arranged. The specific heat of superheated steam will be taken up, an important and exhaustive work which will be presented by a professor of engineering at Cornell. The utilization of low grade fuels in gas producers, combustion control in gas engines, tests of producer gas engines, etc., will be given a session. Other live topics, such as industrial education, power transmission by friction driving, cylinder port velocities, etc., will be discussed. Following are papers to be presented: The Rational Utilization of Low Grade Fuels, by F. E. Junge; A Foundry for Bench Work, by W. J. Keep and Emmett Dwyer; Patterns for Repetition Work, by E. H. Berry; Foundry Blower Practice, by W. B. Snow; Molding Sand, by A. E. Outerbridge; Cylinder Port Velocities, by Jacob H. Wallace; Industrial Education, by W. B. Russell; Power Service in the Foundry, by A. D. Williams; Foundry Cupola and Iron Mixtures, by W. J. Keep; Specifications for Iron and Coke, and Method of Testing Foundry Output, by R. Moldenke; Control of Internal Combustion in Gas Engines, by C. E. Lucke; A Volumetric Study of Cast Iron, by H. M. Lane; Duty Test on Gas Power Plant, by J. R. Bibbins; Some Limitations of Molding Machines, by E. H. Mumford.

The usual entertainments will be provided, and the excursions to various points will include certain notable engineering works now open for the first time to semi-public view. Among them will be the great twin tunnels under the Hudson and East Rivers. The three libraries of the Founders Societies are now open evenings until 9 o'clock.

INDUSTRIAL NOTES FROM EUROPE.

BRITISH TRADE TOPICS.

Though the returns of the principal British imports and exports still show increases as compared with previous years, the ratio of the increases are diminishing, and things generally are coming to a more everyday level. Coincidentally with the general prosperity, conditions are not very encouraging with some of the less prominent branches of the metal working trades, particularly in those sections where these are conducted on what may be called semi-domestic lines. In certain Midland districts a good deal of brass work is produced in small workshops contiguous to the dwellings of the owners, a melting furnace and a few lathes often forming the whole plant. Wonderfully cheap work is turned out of some of these shops in the way of plumbers' and brewers' brass work, such as cocks, valves, unions, etc. Some will confine themselves to goods intended for water service only, others, in a larger business, will give attention to steam work also. Locks and hinges are other goods manufactured on this system, as also a great deal of art metal work. In fact, in the latter class, shops classed as "brass finishers" may prove to be without machinery with the exception of a polishing head or two. Methods employed in the brass trade generally are in a transitional stage, the low fixed costs involved in the home system of production preventing a more general adoption of modern methods. For some time there will probably be a field of machine tools occupying an intermediate position, which will assist both the smaller employers and their workmen to adapt themselves to the changing conditions with as little loss as possible. A method of finishing the conical bore of brass and iron cocks, very generally employed, involves the use of square tapered reamers which are held in a chuck in the lathe, the casting being held in a handle while the cored hole is rough reamed out. A taper fluted reamer is then used for finishing, the teeth being finely pitched to minimize chattering. In some shops square reamers are used both for roughing and finishing, the finishing reamers being "packed" by wood segments, fastened to the reamer by string or wire. These reamers are produced at a very low price by Birmingham makers, who also supply screw threading tools at low rates. When dull, the reamers are usually softened, and filed up by the users, a cutter grinding machine being an almost unheard of luxury; and in fact, it will be rather a problem to supply modern tools for this work, at an attractive price. The taper plugs of the cocks are turned to suit the barrels, and the final process consists of grinding the two together with emery, etc., no attempts being made to secure interchangeability, as more metal may be taken out of one casting than another when turning up, so that the workman keeps each set comprising body plug, washer, and nut, together as he goes on. Of course, there are also large works where work is produced on modern tools, but the small shops have still a fair chance of existence.

Other work produced in quite small shops includes the stamping and piercing of metal work. Women and girls are employed to a considerable extent in several departments of these trades, a remark also applying to bolt and nut making. In the latter branch the work is often subdivided amongst small shops, some making the smaller sizes on hand-bellows-blown forges, and sending them to other small shops to be threaded. The weird-looking tools to be seen in some of these shops, and the quite passable work produced on them, would be a surprise to those accustomed only to modern refinements. One is inclined to wonder if the existence of such establishments is to be commended or deprecated. At any rate they indicate an amount of self-reliance on the part of their owners or founders, which the factory system tends to eliminate, and a certain proportion of these works develops into large factories with more or less well equipped tool-rooms.

Wrought iron and steel fittings, for steam and gas pipes, is a line, the production of which is distributed between large and small works. Tees, elbows, crosses, etc., are cut out from the strip, scarfed, welded, and swedged at a wonderfully quick rate by a smith and a helper. A "shop" will often employ twelve or fourteen men on fittings ranging from ⅛ inch to 2 inches, larger sizes being dealt with at other similar works. In fact, men are known as ¼-inch, ½-inch, or 1-inch "hands," as they confine themselves to one or two sizes only, becoming so expert on these that, when on piece work—the usual system—it does not pay them to change. The forging is often carried out at one shop and the threading at another, the large tube works often subletting contracts for the smaller fittings to the small shops.

Considerable trouble has recently been taken to formulate standard lists and limits for bolt and pipe threads, but the limits have a rather humorous aspect when considered in relation to the threading tackle sometimes used in the "Black Country." We have heard of concerns turning out hundreds of tons of bolts, without a lathe even being on the premises. Yet no taps are bought outside the shops. The taps are forged to size in a forging machine, fluted and then threaded with a screw-plate. Similarly, solid dies are used, and when worn are heated, and closed by swedging and then retapped. Machines for the purpose are made very strong and simple, and fool-proof.

Labor Union Topics.

At the time of writing, the shipbuilding and boiler-making workmen have, by accepting the employers' conditions respecting procedure in case of disputes, averted a threatened lockout, but the railway trouble on the question of recognition, by railway directors, of trades union officials as representing the men in matters concerning conditions of labor, is now entering on an acute stage. The directors have flatly refused to acquiesce in the proposition, and a strike on the question appears probable, but in the meantime Mr. Lloyd George, the president of the Board of Trade, is understood to have an eye to the interests of the general public, and will exert all the influence at his command towards the prevention of a rupture. Otherwise an unprecedented disturbance of commercial, industrial, and domestic economy is threatened.

Fraudulent Use of Trade Marks.

Sheffield is taking active steps to prevent fraudulent use of trade marks, etc., long associated with its products. Government assistance is being given as far as possible, and a public prosecution will be instituted in any definite case brought forward. Much injury has been done to Sheffield's trade in edge tools by its trade mark being used on inferior foreign cutlery, such practices not only diverting local trade, but also lowering a well-earned reputation.

Textile Industry.

Considerable discussion has taken place during the last few years, as to the adaptability of the American Northrop type of automatic shuttle feeding loom to British conditions of working, and the classes of goods dealt with. Mr. A. M. Fletcher, of Hyde, recently read a paper before the Association of Textile managers at Manchester, in which he stated that 790 of these looms were now working at the weaving sheds of Ashton Bros., of Hyde. In spite of much opposition, he considered the firm had brought about a revolution in the weaving trade. An advance of 25 per cent in the wages of the weavers had enabled the married men to earn enough money to keep their wives at home in comfort. He claimed that the Northrop loom did not necessitate the use of better cotton than was used before, and that it placed British firms in a position to compete with the American manufacturers for the Chinese trade.

Machinery Trade Topics.

The *Engineering Magazine* is pointing out that American methods of securing South American trade need revision, and this seems to be borne out by the fact that Mirrlees, Watson & Co., Ltd., Glasgow, have secured the order for machinery for a new sugar factory at Porto Rico in competition with the leading continental and American firms. The value of the contract is about $280,000.

In the machine tool trade, the principal current developments appear in the direction of spur gear hobbing machinery, and special tools for the motor car building trade. In the latter case the requirements of the repair shops are being catered for quite as fully as those of the manufacturers.

Not many years ago cut gearing was over here looked on as a luxury, but such is now far from being the case, and the number of concerns specializing in the gear-cutting line is

now so large that the eclat formerly associated with the business tends to diminish, and there is some danger of competition for orders leading to work very little, if any, superior to the best class of cast gears. JAMES VOSE.

Manchester, England, November 1, 1907.

MISCELLANEOUS FOREIGN NOTES.

MESSRS. G. F. SMITH, LTD., Halifax, England, has brought out a new small-sized radial drilling machine. The arm will swing through a complete circle 6 feet in diameter, and the machine is particularly intended for small work, such as met with in automobile manufacturing. The bed is placed on legs and has T-slots on the front and on the sides. The weight of the machine is about 2,200 pounds and occupies a floor space of 6 feet by 2 feet 6 inches.

MESSRS. J. BUTLER & CO., Halifax, England, have placed on the market a boring and turning mill of very small dimensions, primarily intended for motor car works. The machine is designated as a 30-inch boring and turning machine, but will handle work up to 3 feet 6 inches in diameter. The tool carrying slide can also be fitted with a turret head, an improved device being employed for revolving and securely holding the turret. The machine will swing pieces 33 inches deep under the turret, and 29 inches deep when employing boring bars. The vertical feed of the tool bar is 14 inches and that of the turret 24 inches.

RUSSIAN TRADE CONDITIONS.—The German consul at Moscow reports to his government that the imports of machinery to Russia in 1906 were smaller than had been expected, due partly to the unstable political conditions of the country, about which, it seems from his reports, foreign manufacturers have entertained exaggerated opinions, and partly to increased import duties. The refusal of credit to many Russian dealers of responsible standing has caused an uncalled for decrease in the machinery trade. Germany undoubtedly gets the lion's share of the Russian machinery market at the present time, but conditions are favorable for establishing extended trade relations between the United States and Russia, more so since there now are several direct steamship lines between New York and Russian ports on the Baltic.

THE NORTHERN MACHINE TOOL WORKS, Felling-on-Tyne, England, has placed on the market a new horizontal drilling, boring and milling machine, which is one of the largest of this type of machine that has ever been built. The main spindle is 7 inches in diameter, and has both automatic and hand traverse in and out of 5 feet 6 inches. The column will move horizontally along the bed a distance of 12 feet, and the head will traverse up and down the face of the column a distance of 7 feet, so that the machine will operate over an area of 12 feet by 7 feet at one setting. Power motion is provided for moving the spindle in every direction quickly, and a slow feed is also provided for milling in the vertical or horizontal directions. The approximate weight of the machine is 90,000 pounds.

ELECTRICAL INDUSTRIES IN GERMANY.—The electrical industries in Germany are in a satisfactory state, and the great economy of expense and labor obtained by the electric transmission of power has, it is claimed, opened up ever-increasing fields of operation in the mining and iron industry. Last year, an electrically-driven reversible rolling mill was constructed, which enabled the production of energy in the mill where it was installed to be completely centralized, and increased the output of the rolling mills by fully 10 per cent. This success is noteworthy, as reversible rolling mills were heretofore driven exclusively by steam engines. A further interesting accomplishment of the German electrical industry is the construction of a continuous current electromotor for driving a converter blast. This electromotor has a capacity of 2,000 horse-power, and is one of the largest of its kind.

INDUSTRIAL PROGRESS IN INDIA.—There is at the present time an unparalleled industrial activity even in the remotest part of the world. It is reported from Calcutta that iron works and a steel mill will be established in India, and it is intimated that this departure marks the beginning of an industrial era in that country, and that the markets of India will in a near future offer opportunities to machinery builders. Of course, the English manufacturers will have some advantages in this trade over American machinery builders on account of the political tie between India and Great Britain, but it will not be out of the way for our manufacturers and dealers to keep close watch of the industrial development of a country, so rich in natural resources as India. When industrial progress gets a good footing there, the development will be rapid and progressive. The imports for July this year exceeded those of the same month last year by $10,000,000, and the exports by $16,500,000.

BRÖDRENE SUNDT, Christiania, Norway, have placed on the market a new 6-foot vertical boring and turning mill which appears to be an excellent example of modern European machine design. The various details are constructed with a view to surplus of strength so that heavier cuts than those usual can be taken by the machine without fear of failure. The gear box for driving the machine is of friction type with back gears in the ratio of 1 to 7. The vertical and horizontal movements of the heads are independent of each other, and the heads can be swiveled 45 degrees to either side for conical work. The machine can be driven either by countershaft and cone pulley, single pulley or by electric motor, as required. The maximum height of the tool head over the table is 36 inches, the horizontal and vertical movements of the tools being 32 inches. The maximum swing is 73 inches, the table being 57 inches in diameter. A 10 H. P. motor is used for driving, when the boring mill is motor driven.

THE SPREAD OF GERMAN INDUSTRIES.—On account of the increased tariff protection applied by several European nations, a great many large German enterprises have found their foreign trade seriously hampered, and in several instances they have promptly and effectively met the situation by establishing branch factories in the countries where they were most anxious to retain large circles of customers, whose confidence and trade had been slowly gained during years of persistent effort. The tendency to migrate has been most prominently marked by the organization of branch establishments in Austria, and for self-evident reasons it has been most marked among the varied industries of Saxony. Large and successful manufacturing plants, located in the valleys on the north side of the mountain range separating the two empires, have found it a comparatively easy matter to build branch factories on the southern slopes, where climatic conditions are practically the same, and the scale of wages is distinctly lower. Reports from other sections of Germany indicate, however, that the movement is general and widespread, although not so strongly marked as in Saxony.

THE MACHINE TOOL TRADE IN GERMANY.—Recent reports from Germany indicate that there are many persons who believe that the era of prosperity in that country, which has continued uninterruptedly for several years past, is at an end and that business is on the verge of a decline. The more true state of affairs, however, is most probably that the abnormal activity of a few years past is calming down to more normal industrial conditions. The machine shops complain that they do not receive new orders to as great an extent as they have for some time past, but in view of the fact that they could neither cope with the demands on their establishments, nor secure skilled workers, at the time the prosperous conditions were at their height, it was rather to be expected that the amount of new orders would fall off. In general, the iron, steel, and machinery industries are in a satisfactory condition. The export trade is still increasing with considerable acceleration. For the first seven months of the current calendar year there was an increase in exports of machinery amounting to 17 per cent, as compared with the exports of 1906. At the same time the imports of machinery have increased by 11 per cent, plainly indicating that there is no serious reaction as yet. The increase in exports and imports referred to is made on the basis of weight. If value were considered the percentages would be still higher, owing to present increased prices of machinery. In spite of these high prices, however, machine tool builders in Germany complain that the profits earned are not what they ought to be, owing to the cost of raw material and to the increased wages. Though deliveries had to be contracted for

six months ahead and more, the machine tool industry showed no inclination to utilize the state of the market for the extension of the works. In the beginning of 1906 the home orders were shelved in preference to orders from abroad. The industry subsequently continued to work for the home market, which demanded continuous supplies, though the profits in the home market were not what had been expected; but it was argued that the profits abroad, where increased customs rates had rendered exporting more difficult, were just as problematical. Hence, the present apprehensions, which most likely, however, will prove to be of less significance than expected in some quarters.

* * *

THE MAURETANIA.

Rarely are New Yorkers or the New Jersey crowd of commuters, who nightly cross the Hudson to their suburban homes, treated to so striking a sight as that presented by the turbine liner *Mauretania* as she steamed to her pier on the evening of November 22. The *Mauretania* reached Sandy Hook early in the forenoon after having made her first crossing from Daunt's Rock off Queenstown, Ireland, in about 5 days and 5 hours, but a combination of fog and low tide prevented docking until in the evening. As she slowly moved up the river her gigantic hull was silhouetted against the Jersey shore, the four immense smoke-stacks showing faintly above. Seven decks above the load water line were illuminated—some of them brilliantly—by electric lights. The combination of brilliant illumination, dark background and great size made a most impressive spectacle.

Though a sister ship to the *Lusitania* the *Mauretania* is of even greater size and carrying capacity. (See MACHINERY, August, 1906, and October, 1907). She is 5 feet longer, and because of the use of higher grade steel by her builders, Swan, Hunter & Co., Wallesend-on-Tyne, a considerable saving in gross weight was made for the same strength of hull. This saving increases the cargo capacity about 500 tons without increasing the gross tonnage displacement. In most essentials, however, the *Mauretania* and the *Lusitania* are alike. Although she is conceded to be a slightly faster ship than her mate, the *Mauretania* failed to lower the transatlantic record because of severe weather conditions. However, an indication of future possibilities is found in the fact that 624 knots were run in one day of fair weather. This breaks all previous records. Following are some of the principal data: Length, 790 feet; breadth, 88 feet; depth, 60½ feet; boilers, 25; heating surface, 159,000 square feet; grate surface, 4,060 square feet; Parsons turbines, 4; power, 68,000 to 70,000 H.P.; speed, 25 knots.

* * *

LAYING OUT A PROPELLER.

An article on laying out a screw propeller by Mr. J. S. Watts was published in the September issue of MACHINERY, which gave plain, practical instructions for draftsman. Mr. W. J. Goudie, the author of an English work, "The Geometry of the Screw Propeller," attacked the article in a letter published in the October issue of the *Practical Engineer*, London. Mr. Goudie's attack was based on a misconception of meaning of one paragraph of Mr. Watt's article. He quoted as follows "First, on the development of the blade fill in the dimensions at every 12 inches, by scaling the drawing," and then said: "A reference to the end elevation shows that these dimensions refer to the horizontal intercepts between the vertical axis and the leading and following edges of the expanded blade." In reply Mr. Watts says: "There is nothing in my article to lead any one to suppose that. In any case, the horizontal intercepts could not be determined at that stage of the work. If my critic had read my article carefully he would have found I first drew the development of the blade, that is, a view of the blade laid out flat on the paper, and then added these dimensions by scaling the development, afterward finding out what my critic calls the horizontal intercepts from these dimensions. To make it clear to him I will further say that the dimensions of the development of a blade are the lengths from the various points on the leading edge to those on the following edge, measuring *along the blade*. These were the lengths set off on the inclined sections and are not the horizontal intercepts as he wrongly supposes."

It is unnecessary to quote further from Mr. Goudie's letter, inasmuch as the succeeding criticisms were based on the original misconception. Mr. Watts states that the method has yielded satisfactory results on dozens of propellers. The one used as an example in the September issue has been at sea some months, working in an aperture too small to allow for any serious mistake.

* * *

DISCONTINUANCE OF THE TECHNOLEXICON.

We learn with much regret that the Verein deutscher Ingenieure (Society of German Engineers) has discontinued work on the universal technical dictionary for translation purposes, known as the "Technolexicon." This great work was to have been published in English, German and French, and was begun in 1901. In June, 1906, the work had progressed so far that 3,000,000 word cards had been collected, these being the contributions of 2,000 firms and individuals. The work has turned out to be so costly, however, having exceeded all expectations, that if it was completed within the allotted time the cost would exceed the pecuniary resources of the society. All communications for the "Technolexicon" should be addressed, henceforth, to Th. Peters, Verein deutscher Ingenieure, Charlottenstrasse, Berlin (N. W. 7), Germany.

* * *

DUTY ON ADVERTISING MATTER ENTERING AUSTRALIA.

The following information relative to the rate of customs duty applicable in the Commonwealth of Australia to advertising matter received in mails from other countries has been received by the Post Office Department at Washington from the Postal Administration of Australia. All advertising matter is dutiable at 12 cents a pound. Duty at this rate is levied on trade catalogues, price lists, trade circulars, and all similar advertising matter, introduced through the mails, even when forwarded in single copies addressed to individuals, provided that the total weight of such single copies forwarded by any consignor by any one mail to any one State of the Commonwealth is not less than two pounds in weight. It may also be mentioned that duty at 12 cents per pound is levied on the total weight of magazines, etc., containing advertisements to an extent of more than one-fifth of the printed matter contained within the outside covers.

* * *

FREE ENGINEERING LIBRARY TO OPEN EVENINGS.

On and after Wednesday, November 6, 1907, the reference libraries of the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, and the American Institute of Mining Engineers, 29 West 39th Street, New York, will be open evenings until nine o'clock on all week days except public holidays. These libraries, constituting practically one library of engineering, situated near the New York Library, in the new headquarters of the Engineering Societies, are available to members of the above societies, engineers, and the public generally, subject to proper regulations. Strangers are requested to bring letters of introduction from members or to secure cards from the secretaries of the respective societies.

* * *

CASSIER'S GAS POWER NUMBER.

The November issue of *Cassier's Magazine* is a special gas power number containing 212 pages of reading matter on the general subject of gas power. Among the articles is a historical review of the internal combustion engine by H. H. Suplee (the editor) and discussions upon large gas engines by E. T. Adams, W. H. Booth, and F. E. Junge, representing the practice of America, England and Germany respectively. An important article on the utilization of waste furnace gases is contributed by Mr. B. H. Thwaite, the original chief promoter of the use of waste furnace gases for power. The number as a whole is a notable effort to place on record the developed engineering practice of what promises to be the chief motive power. There seems little doubt but that the gas engine will eventually displace the steam engine, because of its superior economy.

AMERICAN MACHINIST CELEBRATES THIRTIETH ANNIVERSARY.

The *American Machinist* celebrated the thirtieth anniversary of its birthday with a special issue, November 7, which eclipsed all its previous birthday issues in point of size, general typographical appearance and editorial work. There are 532 pages, including the cover, of which 433 are advertising. In this we include the description of the publishing plant. On the front cover is a beautiful and striking allegorical group representing Time, Power and Speed with the legend underneath: "With Time came Power and Speed," the whole typifying, of course, general progress and improvement. The special editorial articles include a review of machine tool progress for the past five years which have intervened since the previous birthday issue, advances in factory construction, cutting steels, constructive materials for machinery, pyrometry, electricity in shops, industrial education, industrial betterment, heat treatment of metals, etc. The issue is in itself good evidence of very material mechanical progress in the matters of machine composition, presswork, papermaking and engraving. And it is also fitting to say that there is abundant evidence of progress editorially in selection, arrangement and all that is included in the manifold activities of the editor of a progressive trade journal. The whole trade press should be proud that the advertising patronage and support of its readers make such issues possible, particularly those which are closely concerned in the machine tool business. It is gratifying evidence of the solidity and importance of the art—a basic art, but one which, perhaps, has not been so recognized until comparatively recent years.

* * *

CARROLL D. WRIGHT RECEIVES CROSS OF THE LEGION OF HONOR.

The Cross of the Legion of Honor has been conferred upon Hon. Carroll D. Wright, former United States Commissioner of Labor, in recognition of his distinguished services as a labor statistician, social engineer and improver in general working conditions. The presentation was made by M. Bonzom, acting French Consul-General, at a dinner given in Col. Wright's honor by Mr. Charles Kirchhoff, editor of the *Iron Age*. The event took place on the evening of November 9, at the Engineers' Club, New York, and was attended by the advisory council of the Museum of Safety Devices, and others. The Museum of Safety Devices is a branch of the American Institute of Social Service, Dr. Josiah Strong, president, of which society Col. Wright is a member. It was considered fitting and appropriate that the presentation should be made under the auspices of the society which is laboring to improve the condition of labor and to reduce the terrible roll of accidents resulting from our present industrial system.

* * *

PERSONAL.

Herbert T. Kehew, formerly auditor of the Crucible Steel Co. of America, is now secretary and treasurer of the Pittsburg Automatic Vise & Tool Co. He succeeds to the position temporarily held by Mr. F. D. Blackburn, resigned.

George A. Gallinger has been made manager of the Pittsburg office of the Independent Pneumatic Tool Co. of Chicago, having been promoted from his former position of general salesman.

Albert J. Ott has been appointed general agent in Illinois, Indiana and Wisconsin for the "Lo-swing" lathe manufactured by the Fitchburg Machine Works, Fitchburg, Mass. Mr. Ott was with the Vonnegat Hardware Co., of Indianapolis, Ind., for thirteen years.

* * *

OBITUARY.

Richard D. Hurley, manager of the Pittsburg office of the Independent Pneumatic Tool Co., died in Chicago November 5 and was buried November 7 at his old home in Galesburg, Ill. Mr. Hurley was only thirty-nine years old, and his untimely death will be a shock to a large circle of friends and acquaintances. He was a brother of Mr. John D. Hurley, vice-president and general manager of the Independent Pneumatic Tool Co., Chicago, and Mr. Edward N. Hurley, organizer and former president of the Standard Pneumatic Tool Co.

NEW BOOKS AND PAMPHLETS.

GEOLOGICAL SURVEY OF NEW JERSEY: Annual report of the State Geologist for the year 1906. 192 pages, 6 x 9 inches. It contains an account of the fire-resisting qualities of some New Jersey building stones; the glass sand industry of New Jersey; properties of trap rocks for road construction; notes on the mining industry, etc. Copies may be obtained from Mr. Henry B. Kümmel, State Geologist, Trenton, N. J.

MACHINE SHOP WORK. By Frederick W. Turner. 190 pages, 6½ x 9½ inches. Illustrated. Published by the American School of Correspondence, Chicago, Ill. Price, $1.50.

This book on machine shop work treats of tools operated by hand and power-driven tools, including the heavy drill press, planing machines, and milling and grinding machines. The matter is prepared in the characteristic manner followed in all the instruction papers of the American Correspondence School, being copiously illustrated and written in simple language. The book will be found of particular interest and value to young mechanics and others who would instruct themselves on the elements of machine shop work.

HOW TO USE WATER POWER. By Herbert Chatley. 87 pages, 4¾ x 7 inches. 23 diagrams and illustrations. Published by the Technical Publishing Co., Ltd., London, and D. Van Nostrand Co., New York. Price, $1.00.

This little book treats of source of power, transmission of power, the hydraulic press, applications of the hydraulic press, water wheels, turbines, pumps, hydraulic engines, tidal power, water supply, sewage disposal and dams. It contains folding plates showing a hydraulic power system, "loss of energy" diagram, guide and vane angles for turbines and section of a reservoir dam.

MODERN STEAM TRAPS. By Gordon Stewart. 104 pages, 4½ x 7 inches. 71 illustrations. Published by the Technical Publishing Co., Ltd., London, and D. Van Nostrand Co., New York. Price, $1.25.

The contents of this book first appeared as a serial in the *Practical Engineer* of London, and it has been reprinted in book form in response to requests. It contains chapters on expansion steam traps, float-operated steam traps, bucket-type steam traps, thermostatic steam traps, differential water pressure steam traps, Bundy steam traps, etc. The book is one that should be of interest to engineers and others connected with steam power plants, and to contracting engineers having to do with the installation of steam power and heating.

MECHANICAL DRAWING. By Irvin Kennison. 142 pages, 6½ x 9½ inches. Illustrated with numerous examples of drawings, lettering, diagrams, etc. Published by the American School of Correspondence, Chicago, Ill. Price, $1.00.

This work is typical of a large number of published works on mechanical drawing. It is gotten up in the characteristic style of the text-books published by the American Correspondence Schools, and should be a clear, concise and valuable aid to the student who would instruct himself in the elements of mechanical delineation. It describes instruments and materials, gives geometrical definitions, geometrical problems and examples of projections, examples of lettering, instructions for tracing, blueprinting, arrangement of assembled drawings, etc.

PATTERN MAKING. By James Richie. 141 pages, 6 x 9 inches. Illustrated. Published by the American School of Correspondence, Chicago, Ill. Price, $1.00.

Pattern-making is an important part of all mechanical construction, and this work endeavors to give a good elementary knowledge of the tools, methods and general construction of machine patterns. It treats of materials and tools, methods of molding, simple and built-up patterns, and gives numerous illustrations throughout. The style of description is simple and well within the grasp of the average man. The book is one that can be recommended to young machinists and others who desire to acquaint themselves with the general requirements of pattern-making, but have no intention of following the art. By this we mean that they wish to understand the needs of the pattern-maker without actually being one.

HYDRAULICS. By S. Dunkerly. Vol. I. 343 pages, 5¼ x 8½ inches. 269 cuts. Published by Longmans, Green & Co., London and New York. Price, $3.00.

Vol. I of this work treats of hydraulic machinery. The second volume will take up the resistance and propulsion of ships. The notes for the first volume were written at the Royal Naval College at Greenwich. The order of the book, by chapters, is: Flow of a Perfect Liquid; Fluid Friction; Pressure Machines; Reciprocating Pumps; Turbines; Centrifugal Pumps. Details are given of a British hydraulic gun brake. Prof. Osborne Reynolds' four-stage turbine is discussed, and the results of trials given; also full details of Prof. Reynolds' hydraulic brake and four-stage centrifugal pump. A valuable feature of the work is a large number of numerical examples with answers in the appendix.

BALANCING OF ENGINES. By Archibald Sharp. 212 pages, 5¼ x 8½ inches. Illustrated. Published by Longmans, Green & Co. Price, $1.75.

This work discusses the balancing of steam, gas, and gasoline engines, and is a most acceptable addition to the literature on the subject which is quite meager. The contents, by chapters, are as follows: Primary Phenomena of Motion and Force; Preliminary Theorems in Mechanics; Inertia Forces of Revolving Masses; Masses Reciprocating in the Same Axial Plane—Long Connecting-rods; Revolving and Reciprocating Masses; Inertia Forces of Second and Higher Orders; Transverse Couples Due to Connecting-rods; Engines with Cylinders in Different Longitudinal Planes; Kinetic Energy of Pistons and Connecting-rods; Torque and Crank-Shafts; Primary and Secondary Balance; Displacement of Engine Frame Due to Unbalanced Forces and Couples; Engines for Various Purposes; Large Gas Engines.

CONSTRUCTION AND WORKING OF PUMPS. By Edward C. R. Marks. 259 pages, 4¾ x 7 inches. 159 illustrations. Published by the Technical Publishing Co., Ltd., London, and D. Van Nostrand Co., New York. Price, $1.50.

This book, which is of the second edition, was first published in 1902. It discusses the elementary principles of pumps, explains their action and shows simple diagrams to illustrate. Various types of pumps are described, including boiler feed, fly-wheel, duplex, Worthington, Mumford & Anthony, Mumford Cameron type, pulsometer compound feed, and a great variety of other types, thus making the work very comprehensive of pumping practice in general, and especially of British practice. Centrifugal and rotary pumps are included, and high-duty pumping engines giving present practice in England and America. The work is one that can be recommended for a concise description of various types and principles involved.

POCKETBOOK OF ELECTRIC LIGHTING AND HEATING. By S. F. Walker. 438 pages, 4 x 6¼ inches. 272 illustrations. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price, $3.00.

This book was prepared with a view of presenting in handy form the information required by central station engineers and others in charge of electric power plants. The first chapter is on electrical units, defining the various units used by the electrical engineer and giving tables of resistance of insulating materials, hysteresis tests on iron; laws of electric circuits, etc. The following chapters take up

electric generators, motor generators, alternating current generators, transformers, accessories for generators, etc., accumulators, switchboards, forms of switches, circuit-breakers, fuses, field-regulators, systems of distribution; cables, method of laying cables underground, measuring instruments, lamps, etc. The book contains a great deal of strictly high grade matter in condensed form; its small size makes it convenient to carry in the pocket.

CHEMISTRY OF GAS MANUFACTURING. By Harold M. Royle. 328 pages, 5½ x 8½ inches. Illustrated. Published by Norman W. Henley & Son, 132 Nassau St., New York, and Crosby Rockwood & Son, London. Price, $4.50.

The work is a practical treatise for gas engineers, students, and others interested in gas manufacture. The author has confined himself strictly to certain aspects of the chemistry of gas manufacture, leaving the manufacture of gas aside. The contents by chapters are: Proportion of Standard Solutions; Coal; Furnaces—Testing and Regulation; Products of Carbonization; Analysis of Crude Coal Gas; Analysis of Lime; Ammonia; Analysis of Oxide of Iron; Naphthalene; Analyses of Fire-Bricks and Fire-Clay; Weldon and Spent Oxide; Photometry and Gas Testing; Carbureted Water Gas, etc. A number of valuable appendices are included. The work is one that should have some interest to chemists and engineers outside of gas manufacture, especially those who have to do with the analysis of coal, combustion, economy of boiler furnaces, etc.

POCKETBOOK OF MECHANICAL ENGINEERING. By Charles M. Sames. 195 pages. 4 x 6½ inches. Illustrated with numerous diagrams. Bound in flexible leather. Published by the author, 542 Bramhall Ave., Jersey City, N. J.

This valuable little pocketbook has passed through two editions, the book in hand being of the third edition. New matter has been added on high-speed steel, superheated steam, reinforced concrete and machine design. The recommendations made for speeds, feeds and cuts in Mr. F. W. Taylor's notable presidential paper presented before the American Society of Mechanical Engineers are given in condensed form; Knoblauch & Jakob's values for specific heat of superheated steam at constant pressure are given; also a table based on other researches giving values for the mean specific heat through the whole range of temperature from saturation up to various pressure temperature conditions ranging from 50 pounds gage to 250 pounds gage. An addition of doubtful value is eight pages of section paper bound in at the back. It is our opinion that most purchasers of the work would prefer to have this space utilized for more engineering matter and to buy their section paper of the stationer. The work as a whole is one that can be heartily recommended to those who desire a condensed handbook of mechanical data.

CATALOGUES AND CIRCULARS.

C. P. MINGST, Evansville, Ind. Circular describing the one- and two-cylinder Mingst marine gasoline engine.

SKINNER CHUCK CO., New Britain, Conn. 1907 price list of Skinner chucks, containing tables of specifications of lathe chucks, planer chucks, drill chucks, etc.

D. SAUNDERS' SONS, Yonkers, N. Y. Catalogue containing illustrations and descriptions of hand tools and machines for cutting and threading steam and gas pipe.

BROWN HOISTING MACHINERY CO., Cleveland, Ohio. Circular of locomotive cranes for handling ore, coal, limestone, slag, etc. These cranes may be used on any standard gage railway track.

GOULD & EBERHARDT, Newark, N. J. Catalogues on automatic gear cutting machinery, and Eberhardt's shapers, illustrating and describing the various types of gear and rack cutting machines and attachments, and the "High Duty" shaper with its attachments.

DIAMOND SAW AND STAMPING WORKS, Buffalo, N. Y. Catalogue No. 13, giving specifications for the Sterling hack saw blades, frames, and power hack saw machine. The special features of the power hack saw machine are: driven by milled gears, tight and loose pulleys, automatic shut-off, gravity feed and swivel vise.

INGERSOLL MILLING MACHINE CO., Rockford, Ill. Catalogue No. 16 of heavy milling machines, showing milling machines of various types, with one, two, three or four spindles, in sizes from 20 inches wide up to 10 feet wide. These machines are suitable for all kinds of work from very light to very heavy milling.

S. OBERMAYER CO., Cincinnati, Ohio. Descriptive matter of the "National" iron filler cement for foundry use. This cement filler is a powder that is mixed with water just prior to using. It hardens and expands at the same time, filling blowholes solidly with a metallized compound that can be readily machined.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4532, descriptive of direct-current motor-starting rheostats, types SA and SO. Type SA is made for one minute duty with no-voltage release; type SO is similar to type SA, but in addition to the no-voltage release attachment it has an overload coil in series with the motor armature.

MANNING, MAXWELL & MOORE, INC., 85-87-89 Liberty St., New York. Circular descriptive of the Ashcroft prismatic water gage for locomotives, marine and stationary steam engines. The glass and its casing are so designed that the water shows black and the steam space has a silvery appearance, thus making the water level unmistakable in any light.

POTTER & JOHNSTON MACHINE CO., Pawtucket, R. I. Catalogue of manufacturing automatic chucking and turning machines, and universal shapers. The automatic lathes are made in 5½ x 10-inch and 8½ x 16-inch sizes, and the shapers in 15- and 24-inch sizes. The catalogue gives tooling diagrams and forms for records of tool positions, and other instructions for the operation of the automatic machines.

WESTINGHOUSE MACHINE CO., East Pittsburg, Pa. Catalogue of Westinghouse storage batteries for portable use. The company has been in the storage battery business for several years, but no literature on the portable batteries has been issued until the present publication. Batteries for trucks, car lighting, electric locomotives, railway signaling, etc., are listed.

ELECTRIC CONTROLLER & SUPPLY CO., Cleveland, Ohio. Booklet entitled "You Can Reduce Operating Costs," which is descriptive of magnetic switch controllers for the operation of electric motors. The booklet illustrates various types of electric controllers, and points out their advantages as compared to manually-operated controllers. Their use undoubtedly has made the electric motor practicable in many services which otherwise would be impossible because of the tremendous electrical overloads temporarily imposed in starting and reversing.

BEAMAN & SMITH CO., Providence, R. I. Catalogue of milling and boring machines built in a great variety of styles to fit individual needs. These include combined vertical and horizontal milling machines, duplex milling machines, four-spindle milling machines, horizontal spindle machines, locomotive port milling machines, boring and tapping machines, cylinder boring machines, engine frame finishing machines, horizontal spindle drilling, boring, tapping and milling machines, pump boring machines, tapping attachments, valve machines, etc.

FITCHBURG MACHINE WORKS, Fitchburg, Mass. Catalogue of the "Lo-swing" lathe. This lathe is "a single purpose machine for increased output and maximum efficiency." It is built for the one purpose of turning shafts and similar machine parts that require to be trued on centers and reduced to one or several diameters, as the case may require. The catalogue illustrates the construction of the machine and the work that it is adapted to, and is a very interesting example of trade literature. Mechanics unacquainted with the principle of this comparatively new machine will find a study of it well worth while.

SENECA FALLS MFG. CO., Seneca Falls, N. Y. Catalogue illustrating and describing "Star" 9- and 11-inch screw cutting lathes, power and foot driven; "Seneca Falls" screw cutting lathes, built in 12-, 14- and 16-inch sizes; speed lathes; wood-turning lathes; and lathe tools, attachments and accessories. The attachments include an ingenious milling and gear cutting attachment which converts the 9- and 11-inch lathes into fairly efficient gear cutters and milling machines, thus enabling the possessor of a lathe to greatly extend its usefulness.

SAWYER BELTING CO., Cleveland, Ohio. "Auto-Calculator" for belts and pulleys, and pocket lumber scale. This handy device is a slide rule made of celluloid and heavy paper board, one side being the slide rule for calculating the revolutions per minute of a driven pulley, having given the diameter of the driver and the revolutions per minute; or for finding the required pulley diameter, having given the revolutions per minute of the driver and driven pulleys, and so on. The opposite side carries the lumber scale, this being a table of sizes of lumber and contents, in board feet. The calculator also gives the belt speed and the horse-power for 4-ply, 6-ply, 8-ply and 10-ply belts for pulley faces 1 to 20 inches.

MANUFACTURERS' NOTES.

CINCINNATI SHAPER CO., Cincinnati, Ohio, has erected an addition to its factory, 90 x 100 feet.

ARGUTO OILLESS BEARING CO., Wayne Junction, Philadelphia, Pa., has been awarded a gold medal for its exhibit of "Arguto" oilless bearings at the Jamestown Exposition.

JANTZ & LEIST, Cincinnati, Ohio, manufacturers of motors and dynamos, are now located in their new shop at the corner of York St. and Western Ave.

THE PHILADELPHIA GEAR WORKS, INC., 1120-22 Vine St., Philadelphia, Pa., held a housewarming, reception and dance at its new building, 1120 Vine St., November 22.

KERN MACHINE TOOL CO., Cincinnati, Ohio, has completed a large addition to its shop which doubles the floor space. The product of the company is upright drills.

NILES-BEMENT-POND CO., Trinity Building, 111 Broadway, New York, has appointed Mr. A. J. Strong representative of the Pratt & Whitney Co. in Eastern Michigan with headquarters in Detroit.

W. F. & JOHN BARNES CO., 231 Ruby St., Rockford, Ill., has completed a large three-story warehouse which was greatly needed to relieve the congestion in the shops.

PITTSBURG AUTOMATIC VISE & TOOL CO., Pittsburg, Pa., was awarded a gold medal at the Jamestown Exposition for its exhibit of vises.

GENERAL ELECTRIC CO., Schenectady, N. Y., made public, following a recent annual meeting of its sales managers, an order booked by the manager of the Pacific Coast territory for a Curtis steam turbine unit of 20,000 horse-power.

FERRACUTE MACHINE CO., Bridgeton, N. J., manufacturer of presses and dies for sheet metals, lately shipped presses to England, India, Austria-Hungary and France, besides several car-loads to points in the United States.

INDEPENDENT PNEUMATIC TOOL CO., First National Bank Building, Chicago, Ill., has appointed Mr. George A. Gallinger manager of its Pittsburg office, 1210 Farmers' Bank Building. Mr. Gallinger was the company's traveling man from its Chicago office.

S. OBERMAYER CO., Cincinnati, Ohio, has published a special edition of the *Obermayer Bulletin* devoted exclusively to the core room of the foundry. It contains a number of valuable articles on core work, and shows certain appliances for producing core work at low labor cost.

TECHNICAL PUBLICITY ASSOCIATION, New York, devoted the meeting of October 31 to "The Mailing List," in securing foreign business. A number were elected to membership. Associations modeled on the lines of this body have been started in Chicago and London.

AMERICAN LOCOMOTIVE CO., 111 Broadway, New York, had a meeting of its directors November 6, for organization, and re-elected the retiring officers to serve for the ensuing year. Mr. S. T. Gallaway was elected secretary to succeed in that capacity Mr. Leigh Best, who has been secretary of the company since its organization. Mr. Best continues to hold the office of vice-president.

HISEY-WOLF MACHINE CO., Cincinnati, Ohio, manufacturer of portable electric tools, has moved into new shops on Township St., Cormany Ave. and Canal. The plant consists of three buildings on a lot 145 feet front by 165 feet deep. The main shop is two stories in height, with light on four sides. The offices and power-plant are in separate buildings.

NOTICE has been received that the International Jury in the section of Social Economy at the International Book Paper and Publicity Exhibition, which closed in Paris last month, made an award of the Grand Prix to the American Museum of Safety Devices and Industrial Hygiene. A diploma of honor, the second highest award, was made to Messrs. Charles Kirchoff and T. C. Martin, respectively, chairman and vice-chairman of the museum's advisory council; also to Dr. L. L. Seaman and Mr. Rudolph Lenz for their active interest in promoting the work of the museum. The museum is now occupying the entire fifth floor at 231-241 West 39th St., New York City, and all inquiries for space, exhibits and other information should be sent to Dr. W. H. Tolman, director of the museum.

FULTON MACHINE & VISE CO., Lowville, N. Y., which was burned out early last summer, has rebuilt its plant and is now in full working order. The concern is a stock company incorporated with a capital of $50,000. The officers are: A. S. Stoddard, president; C. T. Boshart, vice-president; E. W. Fulton, secretary and treasurer; T. S. Dibble, superintendent. The machine shop is 35 x 110 feet and is built of concrete blocks. The foundry is 35 x 95 feet. The product at the present time is "Star" solid jaw vise and a patent high-pressure valve.

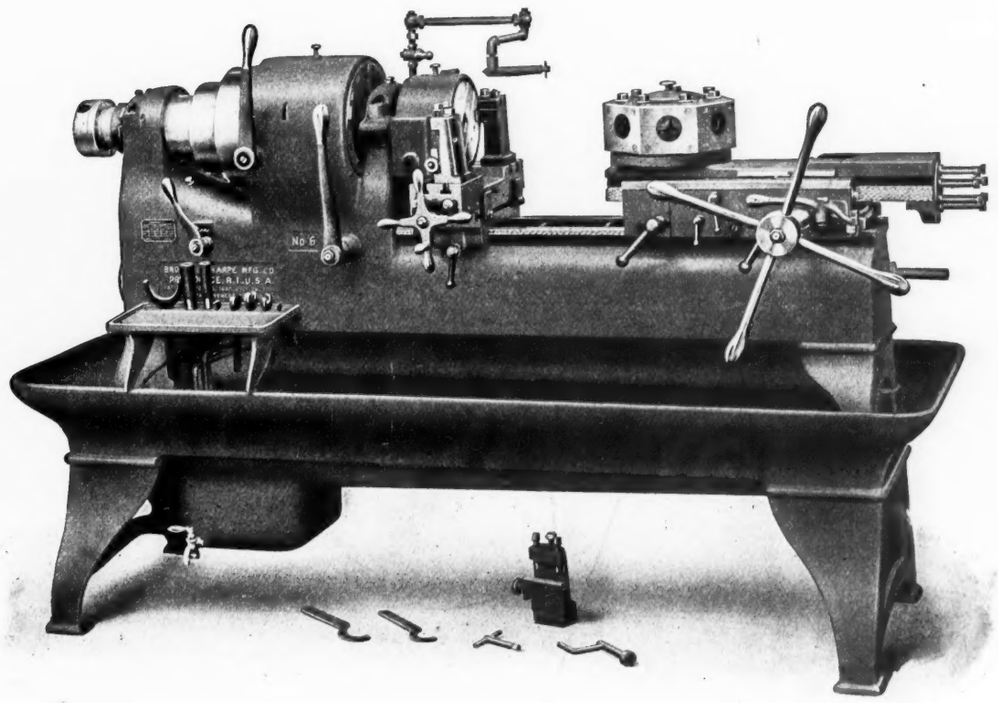
INDIANAPOLIS MACHINE TOOL CO., Indianapolis, Ind., builder of the new Libbey turret lathe, expects to be in its new factory and in full operation January 1, 1908. The new shop is located at West 21st St. and the Belt Ry. on a 4½-acre plot. The building is constructed on the unit plan and may be extended at any time in harmony with the existing plan. The main building is 100 x 150 feet. It has galleries on each side 25 feet wide and 10 feet wide across the ends. The main and gallery floors are of concrete. A 48-foot span electric traveling crane, capacity 5 tons, built by the General Pneumatic Tool Co., Montour Falls, N. Y., is provided for handling the work. The turret lathes will be built in large lots.

NILES-BEMENT-POND CO., Trinity Building, 111 Broadway, New York. Catalogue of high-duty cold sawing machines built by the High-Duty Saw & Tool Co. These machines are equipped with the "Tindel" inserted tooth saw, which is of the simplest construction. It consists of a saw blade or body and the cutters only, there being no auxiliary parts required to hold the cutters whatever. The cutters are inserted in dovetail radial slots milled alternately on opposite

BROWN & SHARPE MFG. COMPANY

PROVIDENCE, R. I., U. S. A.

No. 6 Wire Feed Screw Machine



CAPACITY :—Hole through spindle, 1⅝". Length that can be turned, 10" Swings over bed, 18"; over cross slide, 8¾". Roller Feed.

FOR Work within its Capacity, its Accuracy is sure. A factor of prime importance, insisted upon in the manufacture of B. & S. Screw Machines, is *Quality of Workmanship* as absolutely essential to the best results. Accuracy is established by such emphasis and no detail where alignment is required is overlooked. The testing of each machine before it leaves the shop is of such rigid character that Accuracy is positively insured.

A circular of this machine, describing it in detail, sent to any address on application

CONTENTS FOR DECEMBER.

TUMBLER GEAR DESIGN. John Edgar..... 207
NEW BUILDING FOR THE AMERICAN SCHOOL OF CORRESPONDENCE 209
BRITISH FILE-TESTING MACHINE..... 210
DESIGN OF LIGHT STRUCTURAL JIB CRANES. W. H. Butz.... 211
DERIVATION OF THE CROSS-ROLL CURVE. Ulrich Peters..... 214
SHOP PHOTOGRAPHY. Carl S. Dow..... 215
BILL'S GARAGE. Ethan Viall 220
SAFEGUARD IN MACHINERY. W. H. Booth..... 221
NOTES FROM THE OLYMPIA EXHIBITION. James Vose..... 222
ON DETERMINING SIZE OF FLY-WHEELS FOR MOTOR-DRIVEN PLANERS. W. Owen 224
SOME OLD MACHINERY CATALOGUES..... 225
THE MACHINE SHOPS DON'TS AS A SPIRITUAL FORCE..... 225
REAMERS.—5. Erik Oberg 226
THERMIT REPAIR OF STEAMSHIP STERN FRAME AND RUDDER POST 228
EDITORIAL 230
GOVERNING DEVICE FOR INTERNAL COMBUSTION ENGINES..... 233
INDUSTRIES OF BIRMINGHAM..... 234
THE PRESENT POSITION OF THE GAS ENGINE..... 234
HIGH SPEED ELEVATORS 235
STANDARD PROPORTIONS FOR MACHINE SCREWS..... 236
BALL BEARINGS—I. 237
ERECTING MACHINERY FOUNDATIONS. J. A. Pratt..... 240
NEW SHOP OF J. E. SNYDER & SON. H. P. Fairfield..... 243
THE BURGLAR AND THE SAFE MAKER. George P. Pearce.... 244
TURNING A 76-INCH PULLEY ON A 60-INCH BORING MILL..... 244
AN OLD-TIME APPRENTICESHIP. Back-number Apprentice.. 245
MAKING SPRING COLLETS. J. J. Voelcker..... 246
TOOLS FOR BORING AND TURNING SPACING COLLARS. Chas. Thiel 247
TABULATING DIMENSIONS OF TOOLS. Tool Designer..... 247
CANNON FOR SHOP USE. H. K. Griggs..... 248
TOOLS FOR WINDING SPRINGS IN AN ENGINE LATHE..... 248
CUTTING TRIPLE THREADS. Fred Seaburg..... 248
GRINDING THREADING DIES 249
METHOD OF DRILLING CURVED HOLES. K. R. Cross..... 249
DEVICE FOR MAKING WAX FILLETS. M. R. Kavanagh..... 249
LAYING OUT OFFSET LEVERS. E. R. Seiter..... 250
TOOLS FOR SCRAPING. Sirius..... 250
INSERTED TOOTH MILLING CUTTER. S. A. McDonald..... 250
FACING WORK BETWEEN CENTERS..... 251
TURNING THE WRIST-PIN OF A CROSS-HEAD. W. L. McLaren. 251
WORM-CUTTING TOOL. Albert Andrews..... 252
MULTIPLE SPINDLE DRILLING DEVICE..... 252
SHOP LIGHTING 252
SECURING THE INK BOTTLE. C. H. Ramsey..... 252
CONTOUR GAGE. Howard D. Yoder..... 253
GALLING OF METALS. W. S. Leonard..... 253
SHOP KINKS 254
HOW AND WHY 255
NEW MACHINERY AND TOOLS..... 256
INDUSTRIAL NOTES FROM EUROPE. Jas. Vose..... 270

sides of the saw blade to a depth of slightly over one-half the thickness of the blade. Thus there is made no break in the continuity of the blade periphery, the result being a very rigid strong inserted tooth construction. The "Monarch," "Paragon" and double slotting machines built in various forms are illustrated and described; also samples of work, construction of saw, saw grinding machine, etc.

COMING EVENTS.

November 30 to December 7.—Eighth Annual National Automobile Show, National Association of Automobile Manufacturers, Coliseum, Chicago, Ill.

December 3 to 6.—Annual Meeting, American Society of Mechanical Engineers, Engineering Societies' Building, 29 W. 39th St., New York City. Calvin W. Rice, secretary.

December 5 to 7.—Society for the Promotion of Industrial Education, Convention at Chicago. C. R. Richards, Columbia University, New York, secretary.

December 16 to 21.—First Annual Hartford Industrial Show in Foot Guard Hall, Hartford, Conn. R. B. Jacobs, Jacobs Mfg. Co., Hartford, Conn., Promoter.

MISCELLANEOUS.

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

A WELL-EQUIPPED UP-TO-DATE MACHINE SHOP, manufacturing high grade specialties, desires to secure the manufacture of hardware specialties, model machines, tools, punch press work, dies, etc. Address PENNSYLVANIA SPECIALTY MFG. CO., care MACHINERY, 49-55 Lafayette St., New York.

DESIGN AND DETAIL DRAWINGS FOR ENGINES; electrical and general machinery. Locomotive and car works a specialty. Box 191, Plainville, Conn.

DESIGNER EXPERT ON ALL KINDS OF TOOL WORK. Competent to take charge of designing and drafting department of 30 men. Write stating age, experience and salary expected, to E. E. I., 41 West 34th St.

DRAFTSMEN AND MACHINISTS.—American and foreign patents secured promptly; reliable researches made on patentability or validity; twenty years' practice; registered; responsible references. EDWIN GUTHRIE, Corcoran Building, Washington, D. C.

FOR SALE.—Cyclopedia of Modern Shop Practice. A complete reference work for machinists, foundrymen, etc. Leather binding. Four volumes. Cost $18.00. Will sell for $6.00. Address "M. R. T.," Box 425, Chicago, Ill.

FOR SALE.—Cyclopedia of Engineering. Five volumes. Bound in three-quarters red morocco leather. Used but little and are in first-class condition. Cost new $19.00. Will sell for $9.00. Address "F. T. B.," Box 425, Chicago, Ill.

FOR SALE.—A twelve-volume engineering library. Steam, electrical, mechanical. Cost new $60.00. Is in first-class condition. Will sell for $18.00. Address "A. R. F., Box 425, Chicago, Ill.

FOR SALE.—Nine dollars gets an up-to-date set of books on electricity. Five volumes. Bound in morocco leather. Cost new $19.00. Are in excellent condition. Address "A. M. L.," Box 425, Chicago, Ill.

FOR SALE.—New Loew Victor Hand-Power Pipe Machine, cutting from one to four-inch. Address Box 143, care MACHINERY, 49-55 Lafayette St., New York City.

FOR SALE.—One 6-H.-P. and one 2½-H.-P. Meitz & Weiss kerosene engine. In good condition. Low price. LUMEN BEARING CO., Buffalo, N. Y.

FOR SALE.—Newcomb Engine, patent riding cutoff, throttling governor, in first-class condition in every particular. Diameter of piston, 15 inches. Stroke, 36 inches. Now doing 72 revolutions per minute, developing 90 H. P., under pressure of 80 lbs. THAYER-FOSS CO., Peabody, Mass.

FRANCE.—Do you want to do business with France? I am contractor to the principal European railway companies, and have an important connection among the great constructors, engineers, mines, and automobile makers. I can introduce a suitable specialty. Have you one? No antiquities required. Would undertake agency of first-class high-speed machine tools for heavy cuts. Only sound firms treated with. Established 10 years in Paris. Best references given and required. Address MACHINIST, c/o The Galignani Library, 224, Rue de Rivoli, Paris (France).

HELP WANTED.—The following positions are open in our new Gas Engine Works.

SALES MANAGER to look after the wants of, and obtaining agencies. An office man of large calibre, pleasing personality, fine correspondent, one who can obtain and hold large agencies. Salary $1,800.00 to $2,400.00 per year, also interest in a highly profitable business after worth is demonstrated.

SUPERINTENDENT for works of 30,000 floor space to operate two hundred hands, want not less than two thousand engines per annum, 3 to 40 H. P., at lowest possible cost. Factory equipment the very best and latest, must be an organizer of men, and a systemizer of large experience. Salary $1,800.00 to $2,400.00 per year, and interest in business, also.

CHIEF CLERK, experienced in checking in and outgoing invoices, doing some buying, and repair order man. Salary $85.00 to $100.00 per month.

STOCK CLERK, a competent inspector of work entering stock room, who can pass on its grade, properly take care of it, receive shipments, etc. Previous experience expected. Salary $100.00 per month. WITTE IRON WORKS CO., Kansas City, Mo.

MACHINISTS' AND DRAFTSMEN'S TABLE of standard, steam, gas and water pipes and tapping sizes, 10 cents per copy. Shop agents wanted everywhere. E. E. MEYER, Allegheny, Pa.

MINING ENGINEER with extensive acquaintance among western mining men would accept position as traveling sales agent for first-class machinery house; mining machinery preferred. Only those wanting first-class man at good salary need answer. Address Box 148, care MACHINERY, 49-55 Lafayette St., New York.

PATENTS.—H. W. T. Jenner, patent attorney and mechanical expert, 608 F Street, Washington, D. C. Established 1883. I make an examination free of charge, and report if a patent can be had and exactly how much it will cost. Send for circular. Member of Patent Law Association.

SHOP DRAWINGS, detail tracings and blue prints. Prices reasonable. Address W. H. DEXTER, 22 Mechanic St., Orange, Mass.

TAPS.—Wanted, automatic machinery of modern design for manufacturing taps. Would buy patents of a perfect machine already running. Write to HEINRICH DREYER, Importer of American Machinery, Berlin C. Kaiser Wilhelmstrasse 1.

TOOL MAKER.—A-1 practical mechanic experienced in the manufacture of tools in all its branches and having experience in handling a large force of men. None but a man with such experience need apply. Write stating age, experience and salary expected. H. S. P., 41 W. 34th St.

WANTED.—Agents in every shop to sell Calipers. Liberal pay. Address E. G. SMITH CO., Columbus, Pa.

WANTED.—Agents, machinists, toolmakers, draftsmen, attention! New and revised edition Saunders' "Hand Book of Practical Mechanics" now ready. Machinists say: "Can't get along without it." Best in the land. Shop kinks, secrets from note books, rules, formulas, most complete reference tables, tough problems figured by simple arithmetic. Valuable information condensed in pocket size. Price postpaid $1.00 cloth; $1.25 leather with flap. Agents make big profits. Send for list of books. E. H. SAUNDERS, 216 Purchase St., Boston, Mass.

WANTED.—A man to take charge of a sheet metal department, where diemaking and deep drawing in steel are specialties. State experience and wages expected. Address Box 149, care MACHINERY, 49-55 Lafayette St., New York.

WANTED.—Men to work on large forging dies. State experience and wages expected. Give references. Address Box 150, care MACHINERY, 49-55 Lafayette St., New York.

WANTED.—Machinists to build our boat motors; there is money in it; our catalogue (W) tells how to get it out. GIANT MOTOR CO., Newark, N. J.

WANTED.—Position as foreman or assistant superintendent by a practical mechanic, 30 years; thoroughly understands the manufacture of small mechanical products and the handling of help. Can furnish A1 references as to ability. Address Box 151, care MACHINERY, 49-55 Lafayette St., New York.